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Present educators, architects, engineers, and building product manufacturers with a medium of common interest for discussion of mutual school construction problems, objectives, needs, ideas, capabilities and limitations. Contents include--(1) modern wood construction, (2) school room in a steel mill, (3) masonry in new school design, (4) the "good" school: a human instrument, (5) gas-fired equipment for schools, (6) laminated wood and built-up roofing, (7) Kimberly: a total learning environment, (8) daylight as main illumination source, (9) prefabricated metal curtain wall, (10) glass conditioning in modern schools, (11) metal doors/frames in modern schools, (12) space grid system for school design, (13) schools and the flexibility factor, (14) plexiglas for glazing and light control, (15) schools: high, wide, and handsome, (16) low maintenance with a preformed film, (17) lighting for learning areas, (18) floors for use and abuse, (19) school: a home away from home, and (20) laminated plastic applications in schools. (RH)

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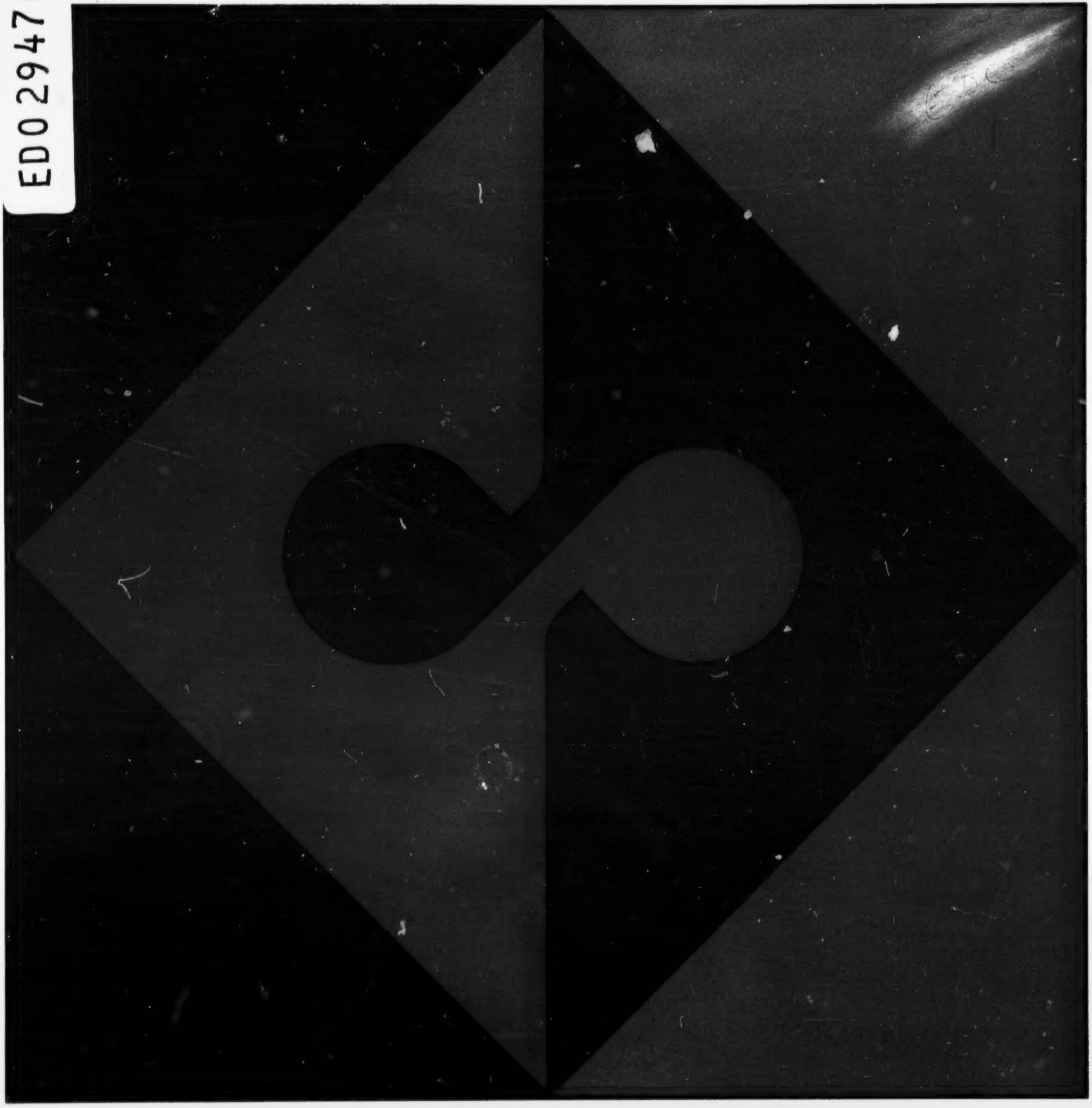

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NEW IDEAS FOR SCHOOL CONSTRUCTION

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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"We are currently in a rising trend of the biggest 'bull market' in the history of education. According to government figures there are now some 48 million students enrolled in elementary and secondary schools, and this figure is expected to increase by 4 million in the next five years. Four hundred thousand new classrooms will be needed to meet this growth. Almost half a million of our existing classrooms are already more than 30 years old. Elementary and secondary education accounts for 71 per cent of our national expenditure for education.

"The same is true of higher education. Today there are 5.2 million students in our colleges and universities. This is double what it was 15 years ago in 1950, and it is expected to double again in the next 15 years to over 10 million by 1980. The total operating cost of higher education was estimated at $4.3 billion in 1962. It is expected to reach $15 billion by 1980. Capital expenditures are currently about $1.2 billion a year and the trend is up.

"What is true of quantity is also true of quality. The phrase, 'bigger and better' is no longer a cliché when applied to education but a realistic description of the present situation and the future prospect."

—ALFRED T. HILL, Ph.D., Executive Secretary, Council for the Advancement of Small Colleges

Earl F. Bennett

Leo B. Harrison

STATEMENT OF PURPOSE

PRODUCERS' COUNCIL SCHOOL CONSTRUCTION SEMINAR

Educators, architects, engineers, and building product manufacturers comprise a seemingly diverse group. Our professional backgrounds and individual interests vary widely. Yet, with respect to schools, we have much in common.

First, as citizens, we share the common responsibility of all Americans for the proper education of our youth. Obviously, the educators among us play a dominant role in achieving this objective. We must pay them special heed. But educators cannot educate, or students learn, without adequate physical facilities within which the teaching-learning process can effectively occur. It is the task of the architect and engineer to devise and to design such facilities. Nor are designs on drawing boards enough. The manufacturer's role is to produce building materials, equipment, and systems with which school designs can best be translated into the hard reality of schools under construction.

Among participants in the School Construction Seminar, therefore, a clear pattern of inter-dependence emerges. Plainly, to the extent that any of us fails, none can fully succeed. It is apparent, too, that none of us can succeed if each of our groups pursues an independent course. Cooperation and coordination are vitally necessary. Discussion is required.

And that, basically, is the purpose of the Seminar: to provide participants with a medium—and an interested audience—for discussion of mutual school construction problems, objectives, needs, ideas, capabilities, and limitations.

To conduct the discussion in practical and orderly fashion, the Seminar program in each of the Producers' Council's 48 chapter cities consists of four phases: (1) a keynote address by a speaker of national prominence in the educational facilities field; (2) an open discussion between the audience and a panel of local professional people—educators, architects, and engineers; (3) an open discussion between the audience and a panel of building product specialists; and (4) manufacturer exhibits of building products and systems.

Through an exchange of ideas in this context, hopefully, will come understanding. And through understanding, hopefully, will come some solutions to the problem of school construction in the modern era—an era in which a student population explosion is occurring concurrently with an explosion in product, design, and construction technology; an era in which an increasingly complex and increasingly mobile society challenges the professional abilities of us all: educators, architects, engineers, and manufacturers alike.

We thank you for attending.

Leo B. Harrison

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The E. F. Hauserman Company
General Chairman
School Construction Seminar

Earl F. Bennett

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Koppers Company, Inc.
Chairman
National Seminars Committee

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2029 K STREET, N.W.
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DESIGN
FOR STRUCTURE
FOR ENVIRONMENT
FOR FLEXIBILITY
FOR MAINTENANCE

■ The role of the architect in school design is that of "approach." This role is expressed by William W. Caudill, FAIA, in his book, *Toward Better School Design:* "Architectural styles change. They wear out in time and decay with imitation. The approach to great architecture, however, remains the same and it grows sounder with time and flourishes with imitation. What is this approach? Actually, it is a thinking process applied to planning. As planners, we might not all agree with every solution offered; in fact, we cannot, for studies offer some conflicting solutions to the same problem. But it is not necessary that we agree; the solutions, however fresh and inspiring some of them might be, are of secondary importance. It is the approach that counts." The Seminar deals with four approaches. They are:

Design for Environment

One of the purposes of a school facility is to create an effective environment for the education of people. The creation of this environment entails the modification of light, sound, thermal factors, texture and color. New avenues of design can be opened by changing these to fit the needs of tomorrow's schools.

Design for Flexibility

Flexibility is that character of design which incorporates fluidity of space, versatility of usage, convertibility of space to use, and expandibility of the structure. These give the desired qualities to the composition of the educational structure. By applying imagination and arrangement in design, a more flexible, thus a more vastly usable, school structure can be built.

Design for Structure

The assembly of structural elements and components to create the required educational environment and flexibility have developed the need for creative structural design. New teaching methods, team teaching tactics, indoor play areas, etc., require different arrangements. The structural demands range from one story to metro-district schools. These requirements can be met with creative design.

Design for Maintenance

Designing for maintenance is an important responsibility in the initial design and planning stage of a school building program. Low cost schools are not always the most economical because the real cost includes ultimate maintenance and operating expenses.

modern wood construction

NATIONAL FOREST PRODUCTS ASSOCIATION*

Building new school facilities is a problem which, sooner or later, every school board in the country will face. Mushrooming enrollment and increasing demands on school plants make expansion inevitable. Many communities—such as Stamford, Houston, Everett and Los Altos—have solved it with modern engineered wood construction.

In selecting construction materials for a new or expanded school building, many factors must be considered. Which material provides maximum flexibility to meet changing educational needs? Will its use create the proper environment for effective teaching and learning? Is the material structurally adequate, safe and durable? Will the proposed structure be economical to build and maintain?

Let's examine each consideration to see how wood, properly used with good design, fulfills school construction needs.

Design for Flexibility

The wood building's adaptability to flat or rolling land, with a minimum of grading, frees the architect from critical site requirements. Wood's great strength and light weight permit structural elements which impose less severe requirements for foundations.

Wood construction's flexibility facilitates character expression through design variability. Roofs may be flat, pitched, gabled, or of many less common configurations —even the ultramodern hyperbolic paraboloid. Roof overhangs provide functional covered walkways, and intriguing shadow lines.

Wall framing variations include post-and-beam, common stud, and heavy timber. Wood and wood-base materials in established and newly developed patterns, with a choice of surface treatments, offer a wide variety of façades.

Rooms, properly utilizing wood, accommodate normal classroom activities as well as audio-visual teaching, without acoustical problems. Large post-free areas can be designed in wood for easy conversion from a cafeteria to an auditorium, a gymnasium, or into numerous smaller areas by using temporary partitions, built-ins and foldaways.

The workability of wood permits school building additions at a minimum cost. Even if the school should outgrow its usefulness, the building can be dismantled

Riverbank Elementary School, Stamford, Conn., is flexible to cope with changing needs. Radial cluster of wood-roofed buildings is adaptable to uneven terrain, expansible for school population increases.

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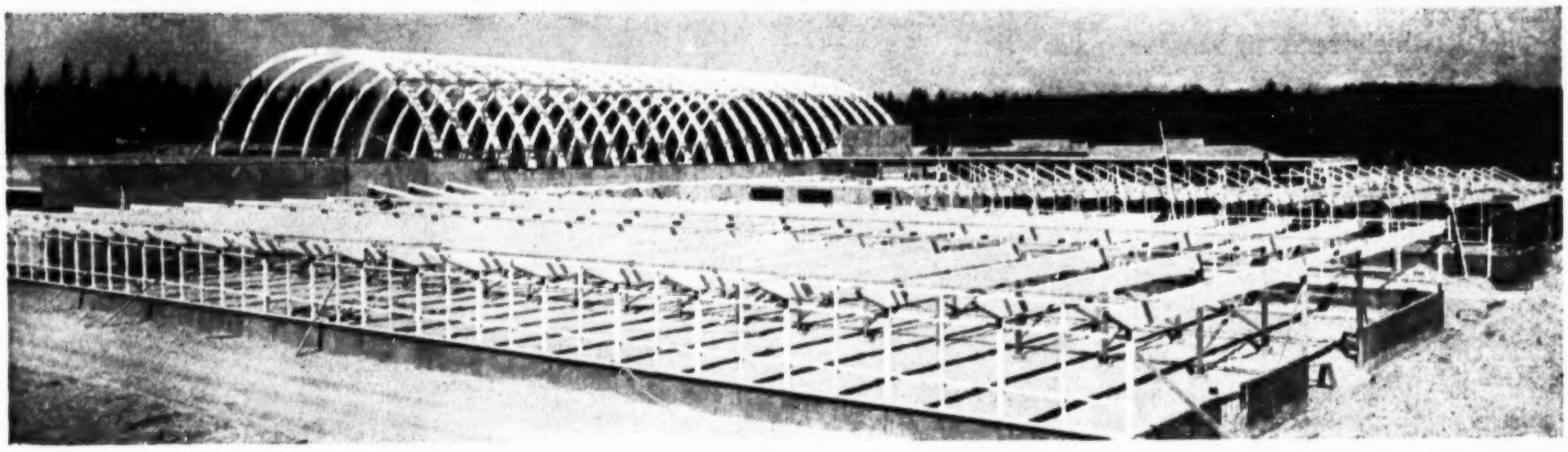
* Formerly National Lumber Manufacturers Association



Lynnwood Junior High School, Seattle, typifies structural and functional efficiency, appearance, comfort, safety, and economy of modern wood.

easier, faster, and with more salvage value, than can heavier types of construction.

The wide use of portable classrooms is a clear indication of the need for flexibility in school buildings. Wood is most suitable for constructing the mobile unit, whether it be a single room containing only desk space and cloak room, or a series of self-contained units that can be joined to form an entire school complex.

Lumber and wood products are readily available, and easily assembled into structures by local carpenters; no highly specialized skills are required. This permits early occupancy of new or remodeled schools to relieve classroom shortages.

It is not necessary to intermix several materials to achieve a combined effect. When a wall, for example, must provide structure, insulation, sound proofing, utility facilities, decoration, ease of assembly, and mobility, all can be provided by even the simplest wood design.

Design for Environment

Modern wood engineering and construction methods will provide strikingly attractive and pleasing surroundings to enhance the educational process in schools. It

Wood decking, on laminated wood beams, serves as roof and exposed ceiling in central building and wings of Stamford school (photo opposite page). Classrooms open into skylighted multi-use area.

Foothills Junior College, Los Altos, Calif., conveys wood's familiar friendliness—in wall paneling, ceilings, floors, exterior siding, trim and wood shake roofs.

affords comfort because of wood's natural insulating property which retards transmission of heat, cold and noise.

Environmental factors exert great influence—favorable and adverse—upon emotional development in children. This fact alerts the architect or interior designer to consider all possible influences of the interior finishing and furnishing of rooms of learning. Small children need the warmth, beauty and other psychological benefits imparted by natural wood to aid them in their transition from the home, and its familiar wood objects to the complexities of school.

Design for Structure

Rising high in the air or hugging the ground, spanning 20 feet or 200, slanted, rounded, flattened, peaked or inverted, skeletal or massive, wood today is serving man structurally as never before. More resilient than other materials, wood can withstand shocks of earthquakes, pounding winds and waters of hurricanes, and heavy loads of snow. Unprotected heavy timber, exposed to fire, performs with greater structural integrity than do many other materials.

Combining beauty and strength, exposed structural systems of wood are an interesting element in the architect's aesthetic concept of classrooms, gymnasiums, multipurpose rooms, libraries, laboratories, shops, offices and lounges. No longer need the architect be bound by rigid geometric shapes.

Wood roof decking can be used structurally to carry the roof load and, as a bonus, serve as exposed ceilings which do not require decorative or acoustical treatment. Wood floor systems, while affording sufficient strength to carry the floor loads imposed by educational uses, provide an area for easy installation of mechanical and electrical equipment. Wood floors also provide the toughness, warmth and resiliency necessary for comfort.

Wood-frame construction makes it easier and more economical for mechanical contractors to install wiring, plumbing and sheet metal work. The inherent insulating property of wood, and the ease with which additional insulation may be installed, mean more efficient and economical air conditioning and heating.

New chemical treatments provide the architect with wood that is resistant to fire, decay, termites and vermin. Among the outstanding industry achievements, in recent years, are the development of fire-retardant treated wood, and its acceptance by building code officials, fire marshals, and insurance rating bureaus.

Design for Minimum Maintenance

Maintenance of any building material depends on the protection given it. Maintenance can be just as important as initial building costs in establishing the economic realities of a structure. Experience has shown the superiority of wood interior wall finishes—stains, varnishes and paints—from a maintenance standpoint. They are durable and retain their clean appearance for many years.

Wood floors can also be readily maintained with modern long-wearing finishes. The good performance of wood gynasium floors, under heavy use conditions for many years, attests to their durability. The maintenance advantages of wood, for interior surfaces, may also be extended to exteriors by using new finish treatments of guaranteed performance, or wood products left to weather naturally.

Operating expenses also may be reduced by insulated wood construction. The low heat-conductivity of wood has become increasingly important with the upward trend in year-round air conditioning. Wood schools have long been preferred in areas with severe winters.

Wood, like any other material, requires maintenance. In the long run, it is one of the least expensive to maintain. Remember, the little red school house of the 1800's didn't wear out; it became obsolete.

Summary

- Wood's inherent beauty, warmth and sturdiness impart a friendly and assuring atmosphere that encourages scholastic achievement and develops emotional stability.
- Wood's attractiveness, being a gift of Nature, enables construction to retain the full integrity of design without resorting to fakery and concealment.
- Fire safety is greatest in the modern one-story school building with ground level exits from each classroom, regardless of construction materials used. Life and property, in the wood-constructed school, are safer from fire, wind, water and earth tremors, than in schools where misconceptions have replaced recognition of true safety factors.
- Wood construction's flexibility provides more freedom of design and function, faster and less costly alterations and expansions, and more encouragement of progress in educational programs.
- Wood construction's durability does not become a liability; the modern wood structure's functional life defies obsolescence.
- Schools of wood construction are compatible with human emotions, with the neighborhood of homes, and with other materials desired or required in building, decorating and furnishing.
- Wood's excellent insulating and acoustical properties eliminate the need for special and costly treatments in walls and ceilings, and reduce heating and air-conditioning expenses.
- Maintenance costs of wood schools are no greater than those of other construction types, and can be less.
- The economies of wood construction, despite somewhat higher insurance rates, result in more actual savings to the taxpayer than he can realize through lower insurance costs.
- Wood construction is economical, but not "cheap." It can provide more enduring quality in safe, attractive and functional school buildings, with less time and money, than can any other type of construction. ◀◀

school room in a steel mill

American Iron and Steel Institute

Improvements and advances in school construction are primarily the result of new developments in building materials and systems. New types and shapes of steel and steel components, for example, skillfully employed by today's architects, help cut costs without cutting corners. Noncombustible steel construction adds a bonus of safety.

The steel industry also is introducing to the construction field the cost-saving and quality advantages of mass production—the same advantages that have made it possible for just about everyone to own automobiles, washing machines, refrigerators, and numerous other convenience items made primarily of steel.

These same developments are greatly expanding and enhancing steel's traditional role as a basic construction material. The result is greatly increased versatility for the architect, increased economy and ease of construction for the builder, improved quality and durability for the owner, and reduced maintenance for the operator.

Steel's broad range of useful physical and mechanical properties are important to architects and engineers in designing today's schools:

Strength—though a high strength-to-weight ratio is inherent in all steels, newer high strength steels are greatly increasing the flexibility of school buildings and enhancing their structural facilities.

Product variety—steel is available in practically any size, shape, finish and strength level, permitting maximum flexibility in creating the proper environment in modern schools.

Elasticity—steel's superior elastic properties contribute significantly to the safety of structures erected in earthquake zones.

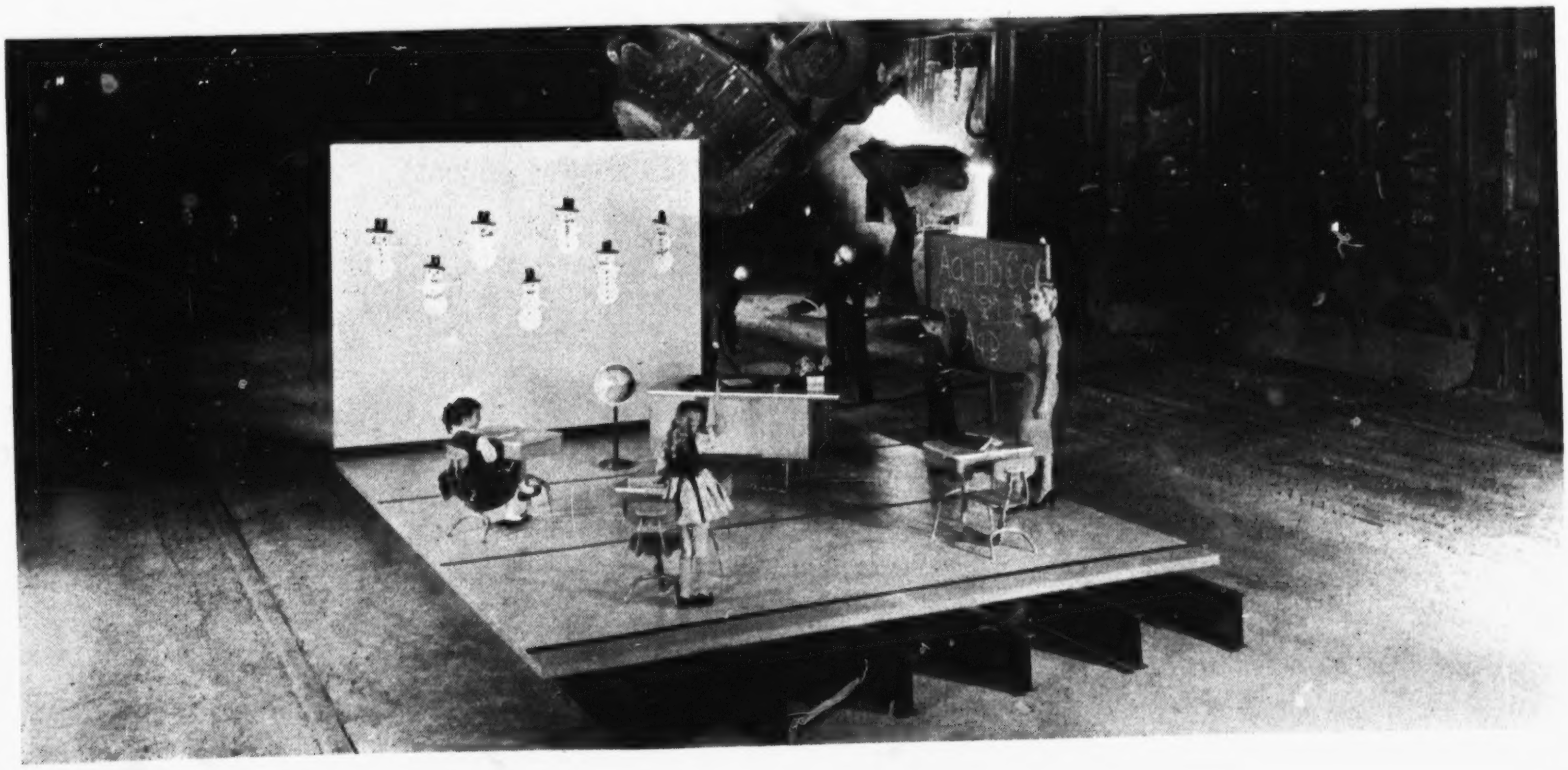
Fire resistance—steel is non-combustible; it neither supports burning nor produces noxious gases, enhancing the safety of a school's structural facilities.

Durability—in building components exposed to daily wear and tear, steel offers maximum service life with minimum maintenance.

Finish—steel building products can be coated easily in any color and texture, creating the modern environment suited for today's schools.

Strength

Steel's strength and its high strength-to-weight ratio make it economical to design just the right structure for a school's needs. Long spans, arches, domes, hexagons and various free forms can be framed in steel utilizing



Exposed steel framing fulfills a double function—it serves as school building's structure as well as a decorative design element in the finished building. This is Joel E. Ferris High School, Spokane.

hot rolled shapes, structural tubing, steel cable suspended roofs, members weld-fabricated from steel plate or cold-formed from steel sheets—either hot rolled, cold rolled or galvanized.

In recent years, new high strength steels have increased strength-to-weight ratios by as much as 50 percent, giving architects and engineers greater freedom in designing long-span structures or column-free areas. While in the past there was essentially one grade of structural steel—ASTM A7—now there are six grades offering a variety of strength levels. Allowable unit stresses range from 33,000 psi to 50,000 psi:

ASTM A7	"Steel for Bridges and Buildings"
ASTM A36	"Structural Steel"
ASTM A242	"High Strength Low Alloy Structural Steel"
ASTM A373	"Structural Steel for Welding"
ASTM A440	"High Strength Structural Steel"
ASTM A441	"High Strength Low Alloy Structural Manganese Vanadium Steel"

The new high strength steels and their higher strength-to-weight ratios, for example, offer greater design freedom as well as important cost saving opportunities in modern school construction. Higher strength in some designs may be utilized to reduce the weight of structural members and lower the overall materials cost for a building's structure. Alternately, a designer may choose to utilize the added strength to create longer spans and reduce the number of roof supports; or, he may increase the size of the building without increasing its cost.

The designer may also specify high strength low alloy steels to reduce maintenance in addition to gaining added strength. In this new family of steels are those which, if allowed to "rust," form a dense surface coating which stops further corrosion. It is esthetically appealing and requires no painting.

In all cases, high strength steels offer added savings in simplified foundations, less fabrication with the same conventional tools and procedures as for carbon steel, decreased shipping costs, increased speed of erection, and reduced maintenance.

Another new steel product suitable for school construction is structural tubing. In 1964, new specifications were published for the first time for these materials—ASTM A500 for cold formed tubing and ASTM A501 for hot formed tubing.

As new steels are introduced, specifications and codes generally are revised to permit their use. American Institute of Steel Construction, for example, published new construction specifications in 1963. They permit architects and engineers to take full advantage of the higher strength levels of the new steels. Often, even newer steels not yet covered by standard specifications are available from producers. The latest data and product information on these steels is readily available to the architect or engineer from the steel producer or the nearest steel service center. The designer may want to contact these sources of information before initiating his designs.

Though structural steels offer great versatility, other steel products also are utilized for school structures. For example, in some designs, structural members are replaced with deeply corrugated steel sheets which are rigid and structurally self-supporting. Such designs permit lightweight structures with long clear spans. For shorter spans, corrugated galvanized sheets similar to culvert sections can be erected as a series of barrel arches for large roof areas.

In recent years, a number of structural systems have been developed utilizing a maximum of prefabrication and

Steel has endless applications inside a school building. Storage cabinets, laboratory equipment, toilet partitions, chalk boards, desks—all can be made of steel in a variety of designs, finishes.

preassembly to speed erection and cut costs. Among steel components for such systems are wall panels fabricated from sheet steel and usually shop finished to further reduce field labor requirements.

Similar steel systems are available for roof construction. For folded plate roofs, for example, special rigid panels are fabricated entirely from galvanized steel sheets and require no structural bracing other than supports at the ends. Because these panels weigh 1/16 as much as concrete folded plate roof panels, they can be erected easily without heavy equipment and permit much lighter structural supports and simpler foundations.

Expansion to meet increasing enrollments or changing curricula is built-in with steel structural systems and enclosing materials. They prove to be ideal in giving today's schools both internal and external flexibility for continuous usefulness and efficiency as schools expand and teaching methods change. Shape and size of buildings do not present any limitations to steel's economy and usefulness as a structural material.

The variety of steel products suitable for structural framing can be designed to permit easy connections when additions to buildings are being constructed. Also, steel framing offers a practical solution for problems created by construction on sloping sites which might otherwise limit the designer or require extensive earthwork.

Steel structural systems also permit easy alterations or additions as well as modernization of older buildings, so that a school can be kept up to date without the cost and time needed for complete rebuilding.

Elasticity—Earthquake Resistance

Though steel provides rigidity and strength far higher than other construction materials, its superior elastic properties permit it to absorb large amounts of energy without damage to the structure. This is especially important in the large areas of the U. S. lying in earthquake zones, where steel construction is almost a must for safety.

Steel's uniformity and predictability of its structural behavior also permit careful study of reactions to earthquakes, resulting in more economical and safer structures. Such research is now underway at several universities throughout the U. S.

Fire Resistance

Steel is a non-combustible material; it neither supports burning nor produces noxious gases. Because it does not melt at normal fire temperatures, it will not cause secondary fires in other areas. Where codes require it, steel structures can be fireproofed easily by applying specified materials to the structural framework.

Durability

Steel building products, such as partitions and wall systems, have the structural integrity of permanent construction, yet permit relocation and rearrangement when needed. Steel's strength and resistance to wear and tear combined with high-quality, factory-applied finishes insure long life for components and a perfect fit whenever relocation is necessary.

Steel doors, windows, chalkboards and similar components require a minimum of maintenance and provide maximum resistance to vandalism.

Finish

Steel structures can be easily protected against corrosion by applying paint or other coatings. Mill applied coatings which are economical and eliminate field labor for painting also can be specified.

Walls and partitions, for example, can be finished in any color or texture to create the desired effects. Finishes include metallic coatings such as zinc, lead and aluminum; paints; porcelain enamel, either glossy or matte; plastic coatings which can be colored and textured to suit any decor; and stainless steels which need no painting or maintenance. The great variety of finishes permits design of building exteriors that blend easily with the character of a community, and interiors that become pleasant environments.

Heating and air conditioning installations also widely utilize sheet steels. Hot air heating systems generally incorporate galvanized steel ducts, though aluminum coated sheets are finding use in this application. The steel ducts are highly fire resistant, and they do not support burning in case of a fire. If hot water or steam is used for heating, nothing is more economical than steel pipe.

Architectural trim, decorative materials and similar building products also are available in a wide range of designs offering the same wide choice of finishes. Doors, partitions and ceilings often incorporate insulating or acoustical materials for efficient temperature and noise control, or they can be combined easily with glass panels.

For mass feeding facilities, stainless steel is the most acceptable material from all viewpoints—sanitation, cleanability, durability and appearance. ◀◀

masonry in new school design

Structural Clay Products Institute

School design since World War II has evolved three distinct types of school buildings, each with its own proponents and its own appeal to communities with individual problems and desires.

The oldest of these types is the "finger" plan school which developed from educational programs calling for classrooms of fixed size. Schools of this type have classrooms strung out along corridors (the rooms often are on both sides of the corridor). Such a design takes maximum advantage of natural daylight and cross-ventilation, but can result in severe problems of glare control and heat gain and loss. Although "finger" plan schools are still built, they seem to be losing some of their popularity to "campus" plan and "compact" schools.

The "campus" design is an appealing solution to the problem of meeting long-range needs. It consists of individual buildings—often "compact" in themselves and relatively small—spread over a large site. Units can be built as needed according to a master plan, and can be connected by walkways or covered passageways.

The "compact" school is commonly defined as a structure with a minimum of conventional window area and maximum flexibility of interior space. They frequently are built around open or skylighted interior courtyards, and often are air conditioned. Such schools can create a maximum amount of educational wall surface, due to the great reduction of window area, and allow maximum use of interior space. In the hands of skilled designers, they create an interior environment that is very conducive to learning and dispel the impression that there is anything very different about the fenestration of the building.

"Compact" schools have been generally accepted by educators. The earlier fears that they might have adverse effects on children have been dispelled by experience, and research is proving that the control of interior environment which is made economically feasible by the cost savings in "compact" schools can be a definite asset to the learning process.

The "compact" school seems destined to gain in popularity, for it is uniquely suited to the educational needs of cities. "Compact" design saves land, and this can be a vital factor in urban areas. In addition, this design can be utilized in multi-story and even high-rise schools.

Brick and Tile Properties

Brick and tile are "traditional" school building materials, but they are even more applicable to the new school designs than the old. The properties which sus-

Amory Middle School, Amory, Miss., a "compact" design by Biggs, Weir, Chandler, Neal & Chastain.

Broad Street School, Nashau, N.H., a "finger plan" design by Carter & Woodruff using exposed brick in corridor walls.

tained their popularity in the past—flexibility, beauty, thermal insulation, fire protection and human scale—are more important in the "new schools" than they were in the old.

It is true, however, that frequently the full range of capabilities that brick and tile possess are not used to complete advantage in schools.

One capability that is sometimes not appreciated is the ability of brick to lower costs of school construction and operation.

A few years ago, a heavily-documented and highly-praised study by two professional engineers, *Ultimate Cost of Building Walls*, was adapted by one of its authors to school design. In the adaptation, a hypothetical classroom enclosed with three alternate materials served as the point of study. Nine identical financial considerations were applied to each of the three wall materials. The study projected their relative costs over a school building's useful life, assumed to be 50 years, and arrived at a relative total cost for each. This final result was the "ultimate cost"*—the total amount a community would have to pay for a school wall over its useful life span. The materials used in the study were a brick cavity wall, a typical metal panel wall and a typical glass window wall.

This study showed that the ultimate cost of the metal panel wall was more than twice that of the brick cavity wall, and the window wall had an ultimate cost nearly five times that of the brick cavity wall.

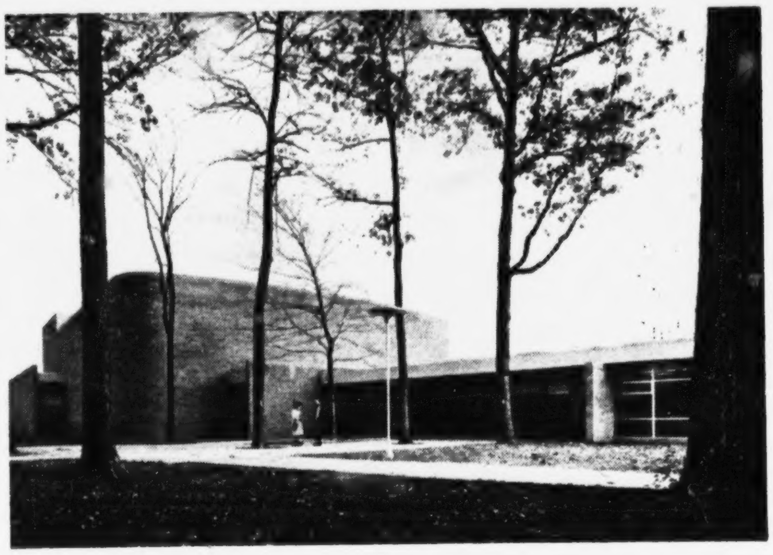
But this does not tell the entire cost story. The study includes maintenance cost as one factor, but does not include wall repairs. Thus there is no provision for replacement of broken glass in the window wall, and the study assumes that metal panel walls will last 50 years without having to be repaired or replaced due to bending, warping or denting.

Brick Bearing Walls

Brick also has great structural capabilities that are frequently overlooked in school building design. It is capable of supporting very heavy loads, and virtually any properly designed brick or structural tile wall will support a one- or two-story school building.

While many new schoolhouses are designed with load-bearing masonry walls, some designs ignore brick's

Southgate High School, Mich., by Eberle M. Smith Associates.



structural properties and use steel or concrete columns for structural support. This relegates brick to the position of a "curtain wall" material and wastes one of its important properties. Such a waste can measurably and unnecessarily increase the initial cost of a school building. It is an extravagance not to take advanatge of brick's unique ability to provide structure, enclosure and interior finish in one.

New high-rise schools in urban areas may also be supported by brick walls. The new brick bearing wall concept*, developed by the Structural Clay Products Institute, permits relatively thin masonry walls to bear the weight of buildings as high as 16 stories. In this design concept, walls and floors act as stiff diaphragms and provide a rigid structural system of great strength.

Masonry Wall Types

The long history of brick use in school buildings has resulted in the development of a great number of masonry wall types applicable to these special structures. Whatever the geographical location of a school, whatever its design, and whatever special needs it may have to meet, there is a brick wall that will do the job.

Six-inch brick walls may be used as a load-bearing wall enclosure within a structural frame. As exterior walls, they lend themselves well to furring, insulating and plastering. As interior partitions, they may be left exposed. Such walls can cut costs if they are used to bear the roof load, dispensing with a structural frame.

The conventional eight-inch masonry wall of brick and tile may also be built entirely of brick. It may be load-bearing or used with a structural frame. The National Building Code of the National Board of Fire Underwriters lists this wall as having a four-hour fire rating when plastered. This is the highest rating generally required in buildings.

Brick and tile cavity walls* consist of two four-inch nominal wythes of masonry units, one of brick and one of tile. Between them is a two-inch cavity which can be left as dead space or filled with insulation material. This wall provides an excellent barrier to penetration of moisture, heat and cold. The interior face may be left exposed, or it may be plastered without furring, lathing or special treatment.

Reinforced brick masonry walls* can be effectively used in areas where unusually severe lateral forces resulting from high winds, tornadoes, earthquakes or hurricanes may be expected. It consists of two wythes of masonry with an interior cavity in which reinforcing bars are placed and then grouted. Where increased concentrated stresses and loads exceed limits for plain clay masonry walls, reinforced brick masonry may provide the solution.

Brick and tile partitions have great application in school buildings. They are usually four, six, or eight inches thick, and all are free standing. Six and eight inch partitions may be load-bearing. They may be left exposed or plastered. Exposed brick or tile partitions are virtually maintenance-free over the entire life of a school. In addition, their low sound transmission characteristics can create economies through compactness of design.

Aesthetic Advantages

One final brick and tile property must be mentioned, for it is as important in schools as any of the above mentioned properties. This is the aesthetic quality of structural clay products.

Drawn from the earth, shaped, and fired in kilns, brick becomes uniquely adaptable to any aesthetic situation or purpose. At the same time, it retains the fundamental affinity to nature and man which is the property of any natural material.

Brick's small size and great range of surface textures enable the architect to form an infinite variety of wall patterns and textures.

Brick colors are practically unlimited. And they are permanent, natural colors.

Because brick can be used in many applications, it serves as an aesthetic unifier. Exposed interior brick walls in schools create a scale with which children are comfortable, and they relate visually to the exterior of the building. In corridor walls, floors, and entranceways, brick links inside with outside. Used in combination, brick softens the cold surfaces of industrial materials. In the "compact" school, brick's pattern, texture and color relieve the masses of large wall areas.

A renowned British architect, Sir Basil Spence, called brick the "best prefabricated building product ever devised by man." Such a tribute is not easily or quickly earned. Brick has earned this compliment through performance stretching back thousands of years, and it is extending its record of accomplishment every day through use in the most modern school buildings of our country.

Materials and Efficiency

The Structural Clay Products Institute believes that school buildings are important‡—and have never been more important than today when each generation of Americans must, largely through education, accommodate itself to and master great and sweeping advances in knowledge.

To laymen, the choice of wall materials to be used in school buildings may seem to be well removed from the efficiency of a school building as an educational tool. But this is not true, as educators know from personal experience.

The predominant choice of brick for use in school buildings reflects an understanding and appreciation of brick's ability to serve education by the educational profession and by architects. New designs for schools will not change this. In fact, new kinds of schools may well emphasize the value of brick, just as school designs evolved since World War II have done. ◀◀

* Additional subject references are available by addressing inquiries to Structural Clay Products Institute, 1520 18th Street, N.W., Washington, D. C. 20036.

‡ *New Trends* in the design/construction/cost of schools (published 1965) is available by writing Structural Clay Products, 1520 18th Street, N.W., Washington, D. C. 20036.

the 'good' school: a human instrument

ZONOLITE DIVISION, W. R. GRACE & CO.

"No matter how excellent that (academic educational) process is, the good school is part of the process itself—a primary aid and a constant stimulus to learning—a human instrument."[1]

The above quote from the work of a prominent architect, best expresses what authorities agree should be the guidelines in planning good school construction. "A human instrument," emphasizes that the school building or envelope cannot be indifferent to the needs—physical or emotional—of its occupants.

Just as proper environment encourages quality performance in industry, so too does it promote maximum efficiency in the learning process and performance of school children. And just as much as a favorable environment will contribute, a poorly planned environment will detract.

This favorable environment, influenced by such variables as lighting, acoustics, temperature, and decor, makes up one-third of the economy-education-environment balance essential to the successful school plant.

Environmental Factor Overlooked

In the past, school planners gave prime consideration to the first two factors, economy and education, while paying little more than lip service to the third. They reasoned, after all, that the public will stand only so much expense, and that the skilled teacher can otherwise compensate for any shortcomings which might exist in the system.

With this line of reasoning having evolved into a kind of deep-rooted, traditional thinking, it is solid tribute indeed to a new breed of planners and architects that the environment factor is today at last receiving its proper share of attention in school planning.

A great measure of credit for this enlightenment is due those engineers, designers, and industrialists who have shown that one can improve environment without sacrificing precious dollars; that in fact, pleasant surroundings and economy planning actually can go hand in hand.

In one way this was accomplished on the accepted premise that heating and cooling efficiency, viewed as an evironment factor, could be substantially heightened while at the same time operating costs were being greatly reduced. Since considerable amounts of fuel dollars escape through uninsulated roofs and walls, the conclusion was an obvious one—insulation.

Roofing Insulation

Warm air's natural tendency to rise causes twice as much heat to escape through the roof as through any other outlet. It follows that the properly insulated roof will serve the dual purpose of comfort conditioning the rooms below, while reducing the amount of fuel needed to do so. This in turn will evidence itself in lower operating costs accompanied by a reduction in heating and cooling equipment. These considerations alone give strong argument for an environment-economy partnership. But the secondary benefits of the lightweight concrete roof deck should also be examined.

Consider first the popular application over galvanized corrugated metal. Large areas are quickly covered with the metal sheets which are then fixed in position by plug welding or self-tapping screws. After venting is provided, vermiculite concrete is applied and forms a monolithic, insulating roof system which is so lightweight (six times lighter than ordinary concrete) that additional savings are often possible due to lower foundation and structural costs. Add to this the applicators' modern, specially designed equipment and the characteristics of vermiculite insulating concrete, and you have a material which can be applied to the paraboloid, vaulted, or any other unusually-shaped roof; a material which can be sloped and shaped during application to meet special drainage requirements; a material that is impervious to wear and cannot burn. Thus the architect is allowed a wide, yet practical expression of his creative talents.

Insulation Savings

To help dramatize the insulating properties of its vermiculite products, W. R. Grace & Co.'s Zonolite Division commissioned a series of school and industrial designs by noted architects from various sections of the country. Among other things, it was intended that these prototypes should illustrate the methods by which an improved environment could also mean substantial savings. Zonolite phrased it best perhaps when they said, "It

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[1] William W. Caudill, FAIA, *Toward Better School Design* (New York: F. W. Dodge Corp., 1954) page 3.

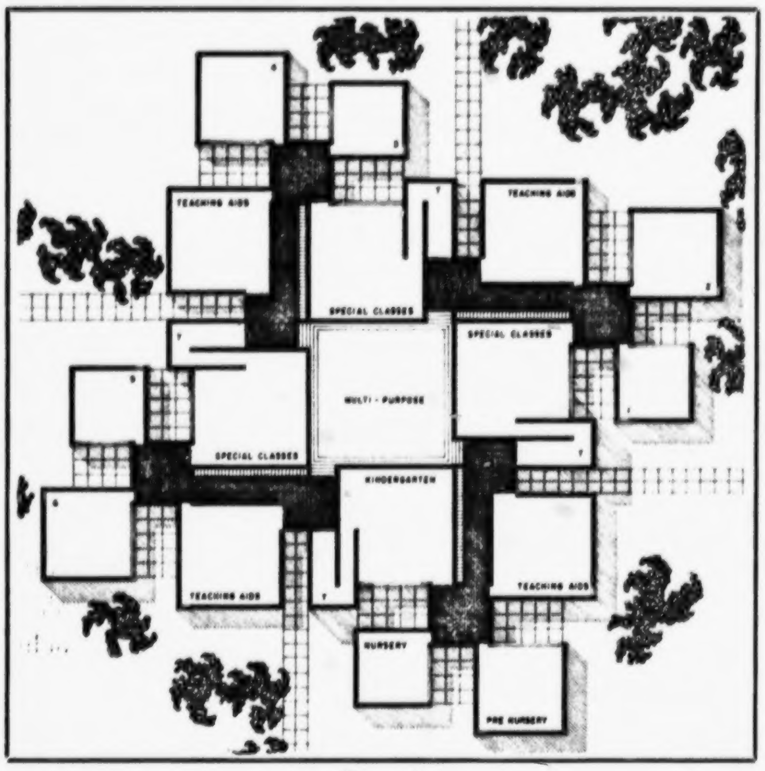


Figure 1

actually costs less to install masonry fill insulation than to leave it out."

The Brick Wall — A Grammar School

The first of these prototypes, by Chicago architect Stanley Tigerman, is a grammar school which is basically a brick cavity bearing wall structure, featuring clusters of classrooms surrounding a focal point multi-purpose room (Fig. 1).

Here, as in all the prototype designs, Zonolite sought to illustrate just how much of an improvement in classroom temperature conditions could be realized with the installation of water-repellent vermiculite insulation in masonry walls, and just what this would mean in terms of classroom comfort and economy. One of the standard drawbacks inherent in the uninsulated cavity wall is the substantial loss of heat by conduction through the interior wythe (Fig. 2A). This causes convection which in turn induces drafts into the classroom, detracting from the general comfort of the occupants. With the uninsulated cavity wall, this is somewhat compensated for by an increased output of the heating facilities, which, of course, also results in higher heating bills.

However, with the installation of masonry fill in the cavity wall, the insulation physically blocks convection, and the temperature of the interior wall rises considerably (Fig. 2B). This results in minimizing convection drafts in the classroom itself and provides a more comfortable, healthier environment.

Figure 2A

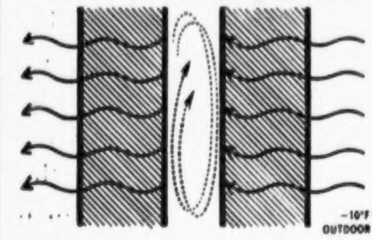
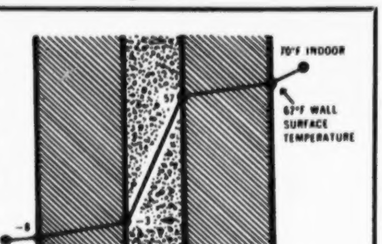


Figure 2B



From a dollar and cents standpoint, Norman Migdal, consulting engineer, estimated that the addition of masonry fill to the 2½-inch cavity wall, a cost of $ .10 per sq. ft. installed, would mean an overall charge of $1,340. Based on 6,113 degree days, $ .10 per therm, gas boiler, and a 45 hour/week ventilation system, Mr. Migdal concluded that this installation would save over $600 per year in operating costs. This in turn means that the installed cost of masonry fill could be recovered in less than 2½ years.

But the true cost of the product must take into account the fact that insulation charges are financed right along with the building. So, at 6% interest over a period of 20 years, the true cost of the insulation is about $140 annually. Compare this with the annual savings of $600 and it signifies a 425% yearly return on the community's investment, while at the same time taking definite steps to improve classroom conditions.

Sound absorption, an ancillary benefit of masonry fill insulation, takes on even greater significance when one begins planning for improved environment. The product's natural absorptive qualities reduce loudness of sound transmitted through the wall by 20 to 31%. This is a significant reduction when we consider the disturbing effect which outside noise can impose on the work of a classroom.

A High School

Results comparable to those of the Tigerman drawings were also seen in the second commissioned prototype, designed by Martin Price of New York (Fig. 3). This is a high school in which the designer wished "to create a homogenous continuity of forms." Rather than place large bulky spaces such as the gymnasium, cafeteria, library, and auditorium next to the contrastingly small classroom spaces, Mr. Price decided to integrate the two by building a "roof" of classrooms over and in front of a "platform" of larger spaces. He juxtaposed the elements in such a way, on a sloping site, "to create an entry court of steps, a meeting place for students."

Again calculations were made with and without masonry fill insulation in the 2½-inch cavity wall. Consulting engineer, Marvin M. Serot found that the cost of the installed insulation would be $1,903. Figured once more on a per annum basis at 6% interest for 20 years, the true annual cost of the insulation became $170.

Engineer Serot, using #6 oil at 7.5 cents per gallon, and 4,989 degree days, estimated an annual operating savings of $405, or a 230% annual return on the community's investment in the insulation.

Other noteworthy savings mentioned by Mr. Serot were reductions in the size of heating and cooling equipment (a Nebraska architect realized a $100,000 savings in this way), and a savings on wall construction and finishing costs. Since the insulation was placed in the cavities, the interior wall surface could be left unfinished

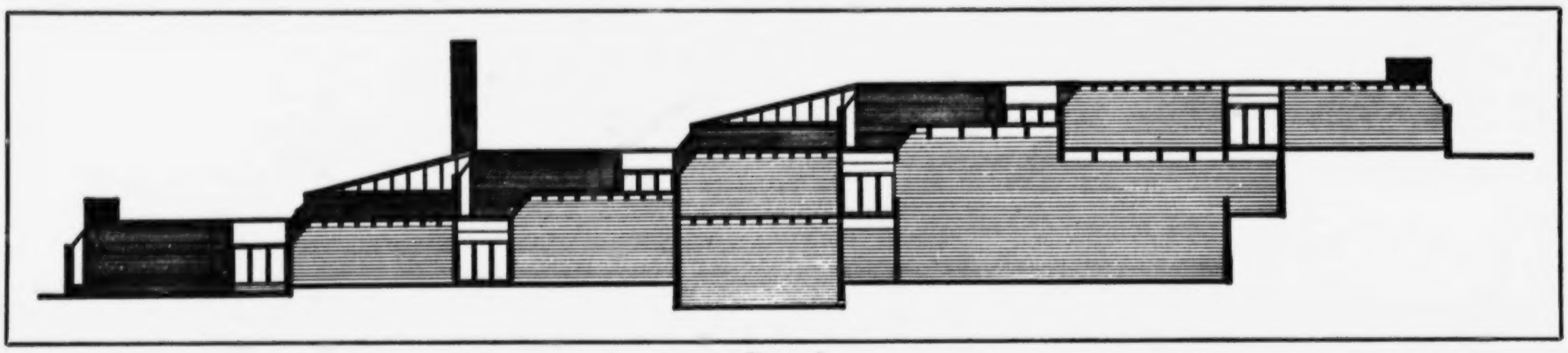


Figure 3

except for paint. This in turn meant that fewer materials and less labor would be needed. Another plus feature was the simple, yet pleasant decor effected by the unfinished wall.

The Block Wall — A Shopping Center

That masonry fill had performed as well in concrete block as it had in brick cavity construction was an accomplished fact. Lending this fact some dramatic overtones, Zonolite commissioned Stanley Tigerman to design three more prototypes, this time in a concrete block series. Tigerman selected a shopping center, a motor hotel, and a light industrial plant.

The first of these, the shopping center (Fig. 4), posed the answer to the challenging problem of developing a complex with maximum tenancy and parking on the conventional 330x660-foot city block. Tigerman depressed the parking eight feet below grade with ramps at four corners of the site. This allows pedestrian and vehicular traffic to move around the project without obstruction. Circulation throughout the complex is a multi-level affair with a series of catwalks running over and through a number of courtyards which surround a central mall.

The structure is of insulated concrete block bearing walls, spanned with hollow precast concrete units containing the necessary mechanical and electrical equipment for such a project.

In this construction, according to consulting engineer Migdal, the use of masonry fill insulation would reduce annual operating costs by $2,480, based on 6,113 degree days, and gas at 7 cents per term for a 70 hour/week ventilation system. At the initial cost of $11,825 for the masonry fill installed, the insulation would pay for itself in less than five years. When based on the true annual cost of $1,040, the community's annual return on its investment is 240%. Comparable returns of 190% and 290% were realized from Tigerman's motor hotel and his light industrial plant, respectively.

In still another concrete block prototype, this one a medical office building by Martin Price, the masonry fill insulation slashed yearly heating and cooling costs by 18% or $357 and returned 160% on the annual insulation investment.

Pursuing the economy factor a step further, a pertinent though somewhat divorced study of apartment buildings conducted by Herman Scherr Associates of New York, found that the installation of masonry fill could reduce the size of heating and cooling equipment to the point where the building in question, *"would be less expensive with the insulation than without it."*

As borne out in the prototypes discussed, the installation of masonry fill insulation in a classroom wall will provide a warmer, healthier environment in winter; a cooler, more comfortable climate in summer; and a marked reduction in the amount of outside noise filtering in—at the same time affording a substantial dollar savings in fuel consumption and labor-equipment.

This same vermiculite which is fireproof, rotproof, and water-repellent, has been successfully adapted to a number of other products used in school construction.

Vermiculite's acoustical plastic and plaster, hand or machine applied to school interiors, offer high sound absorption in addition to fire protection. Vermiculite, as used in the previously mentioned roof deck, signifies considerable construction savings to the community while also reducing heating and cooling costs.

A famous architect referring to school planning has written, "Perhaps the most critical step in the entire planning process is that of translating the desire for the proper environment into envelopes that actually provide that environment."[2]

Conversely, many community leaders voice the opinion that the ever-spiraling cost of building today's school makes the dollar the community's first consideration.

Today, through vermiculite research and development, Zonolite and others have reconciled these two divergent philosophies of school planning. With masonry fill insulation and related vermiculite products, the functional and aesthetic approach of the designer, and the practical cost-consciousness of the community can be fused into the economy-education-environment balance which spells the difference between just a school and a good school, the difference between just a building and "a constant stimulus to learning—a human instrument." ◀ ◀

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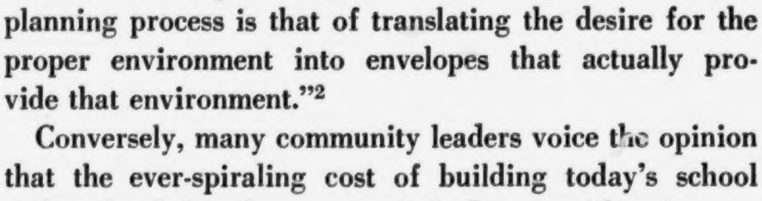
[2] Ibid, page 56.

Figure 4



gas-fired equipment for schools

American Gas Association

A school building must, first and foremost, accommodate the needs of the individuals using the facilities. The job of the designer is to meet the needs of the educator—as interpreted by the school board—to see that the students get the best school plant for the money invested.

The purpose of this article is to provide information on that part of the educational facility: the energy plant and energy applications which provide a suitable environment for learning. It must be remembered that in the design of an energy system for suitable environment this factor will exert a strong influence on the ultimate design of the structure itself, its flexibility in use and its maintenance.

The energy needs for modern schools are reaching new levels of sophistication as air conditioning, high intensity and high frequency lighting and multi-purpose structures of varying occupancies become commonplace. The makers of modern gas equipment offer the most complete line for selection by the architect and engineer. A constant high level of illumination, the introduction of a high volume of fresh air exchange and controlled temperatures and humidity have made for appreciably better study conditions.

The creation of a controlled environment for study can no longer be considered a luxury. Several studies have indicated that school air conditioning may prove to be more economical while providing greater value. Before entering into a discussion of the system for environment control in a school it is imperative that we do not forget the many other energy applications. Several of these represent a very sizable portion of the energy requirements, such as to produce hot water for the food service and cafeteria operations; for the washrooms and showers; for swimming pool heating; general cleaning and laundry facilities; and for hydronic space heating. All of these point up the importance of choosing the proper water heating system.

Solving waste disposal problems through on-premise incineration simplifies the task and reduces the costs of handling, storing, picking up, and hauling waste materials. Not the least advantage of waste disposal through incineration is the fact that fire hazards are eliminated in school buildings. Trash heaps and refuse corners are too easily the origin of flash or major fires. Prompt elimination of wastes means greater fire safety in a building.

School Heating

School administrators have been subjected to much conflicting information concerning methods of school climate conditioning and the relative desirability of using solid, liquid or gaseous fuels or various forms of electric heating. The school administrator needs as much objective information as he can gather to assist him in making the final choice of fuel for either new or modernized school plants.

The choice of heating systems may fall into one of the following five categories:

(1) A conventional hot water system using convectors or radiators usually supplemented with a ventilation and cooling system.

(2) Radiant heating used in combination with a ventilating and cooling system.

(3) A central or zoned system combining heating and ventilating and cooling in the same system of ducts.

(4) A system such as the unit ventilator using individual heating and ventilating units in the space.

(5) Enclosed furnaces for individual room heating where heating unit is specifically approved for use in the room to be heated.

If for any reason comfort cooling cannot be included within the limits of building budget, it would be prudent to select a heating system which can be converted to cooling in the future with a minimum of additional expense.

It may be well to discuss item #5 above in a little more detail. Enclosed furnaces (different in design from conventional forced warm air furnaces) specifically tested for safe classroom use are being installed in many schools. Such furnaces are completely packaged appliances sturdy enough for classroom installation. Jacket surface temperatures are limited to 60°F above room temperature—cooler than a domestic range. Units take all the air for combustion from the outside atmosphere and also vent all combustion products out of doors. The classroom units bring the environment rapidly to a comfort level. Uniform temperatures and even distribution of the room air are maintained at any required ventilation rate.

Gas Powered Air Conditioning

In 1960 the Pinellas County Board of Public Instruction, Florida, demonstrated that an air conditioned school could be built for the same cost as a comparable non-air conditioned school. The Pinellas "experiment," widely publicized at the time, was conducted with two schools especially built for the purpose—the air conditioned Oak Grove Junior High School and the non-air conditioned Pinellas Park Junior High School.

Pinellas County school authorities have continued their research on the two schools and now find that operations costs, on a year-round basis, are not necessarily higher for Oak Grove Junior High than they are for Pinellas Park Junior High. The school authorities are also convinced that air conditioned schools are better for health, for discipline, and for cleanliness. They firmly believe that educational achievement is higher and will build air conditioned schools from now on.

There is a wide variety of gas-powered air conditioning equipment, ranging from gas engine-driven reciprocating and centrifugal compressors to direct gas-fired or steam-powered asborption equipment.

In general, gas air conditioning systems are applied with standard application engineering methods. The major variations in engineering approach, as compared with electrically-operated equipment, are details involving service connections and foundation requirements. Dehumidification units are usually used in combination with all types of refrigeration equipment, the latter a necessity for sensible cooling.

Absorption System

Although the absorption system is not new, its tremendous acceptance in recent years, especially in schools, has led more manufacturers to enter the field with a great range of equipment sizes.

In the absorption system, an absorbent, usually lithium bromide, absorbs vapors given off by water. The continual evaporation of the water, which acts as the refrigerant, provides the cooling. Heat from steam or hot water or from a gas flame in the direct-fired absorption unit is used to regenerate the absorbent by boiling off the excess water vapor.

Direct-fired absorption units are available in capacities up to 25 tons. Direct-fired units up to 25 tons are designed to provide both heating and cooling. Steam or hot-water units are manufactured in capacities ranging from 25 to 1000 tons. Steam pressures of 10 to 12 lbs. may be used. Super-heated hot water at temperatures ranging from 240F to 380F may also be used to operate absorption machines.

The principal features of large absorption units are:

(1) No major moving parts, thus minimizing noise and maintenance costs and assuring long life expectancy. The only moving parts in the absorption system are the solution pumps in larger units. Vibration is also eliminated permitting installations on any floor without added investment in foundations.

(2) Safety with the use of water as the refrigerant, a non-toxic salt solution as the absorbent, and the operation of the system at sub-atmospheric pressures.

(3) Fear of overloading is eliminated, since any overload can be presented to the machine without fear of damage.

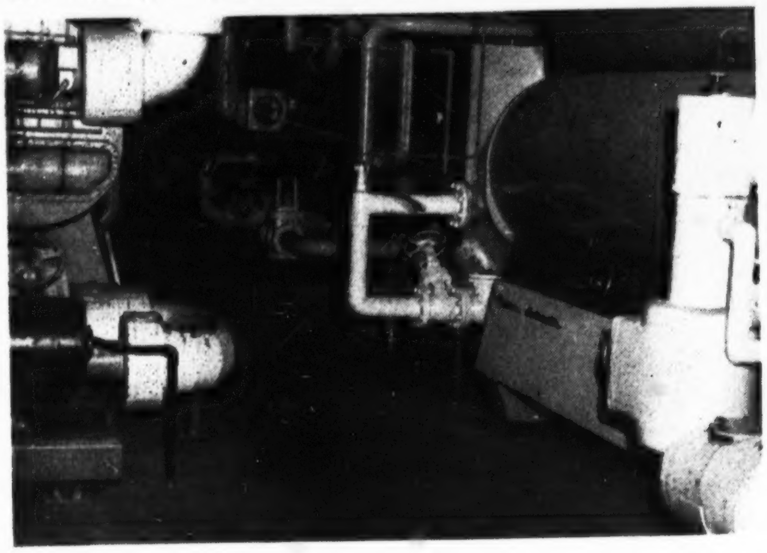
(4) Operating flexibility is at a maximum, since the absorption machine will modulate from zero to full load.

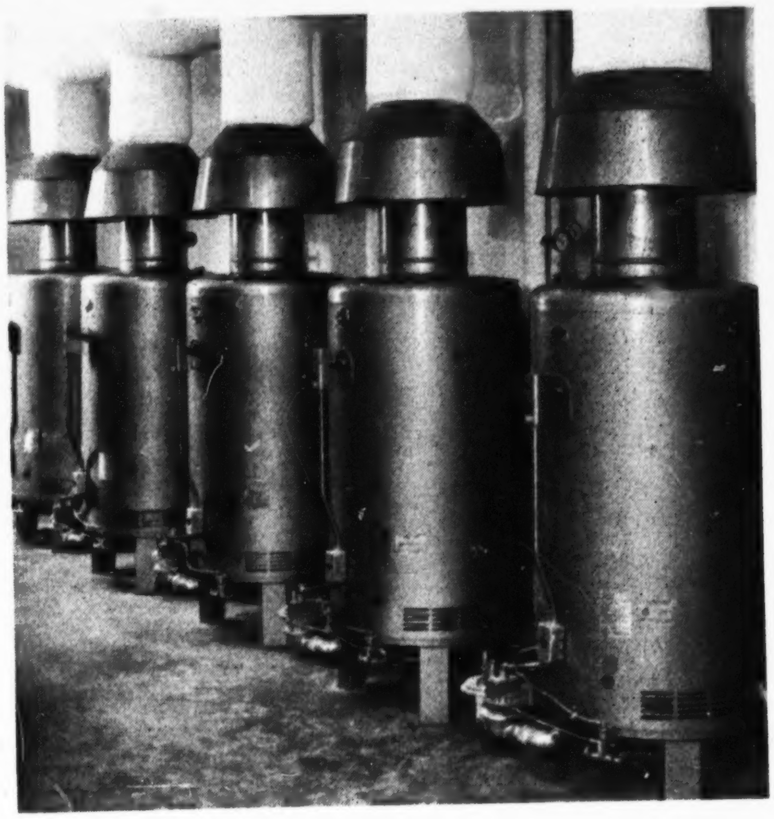
(5) Less floor area is required than in other machines of similar capacity, thus reducing investment charged to air conditioning.

Wiring and electric-service requirements for the absorption unit are small. For example, the maximum

Five manifolded water heaters (right), at University of Dayton, Ohio, require minimum space and can be completely step operated depending on load conditions.

Steam activated water chillers (approximately 400 tons of water capacity) for gas air conditioning system at Temple University.





horsepower requirement for solution pumps on a 700-ton absorption unit is 14½ horsepower.

The initial cost of large-tonnage absorption equipment is comparable to the initial cost of large centrifugal-compression equipment, when the two types are considered on an installed basis. Operating costs of the absorption system will vary according to fuel rates in various locations throughout the country.

Absorption systems are particularly suitable whenever: (1) low-pressure steam is economically available; (2) high-temperature hot water is used for heating; (3) widely fluctuating loads are encountered; (4) local codes require licensed operators for other types of systems; and (5) long runs of wiring would be required for electrically-driven equipment for rooftop installations and where steam is available.

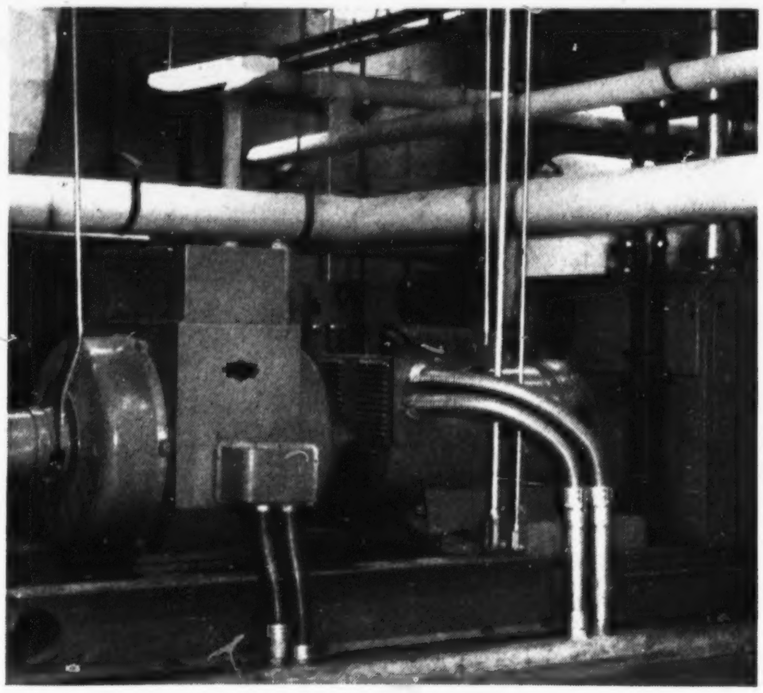
Natural Gas Engine-Driven Reciprocating Compressors

Natural-gas engine refrigeration machines consist of a heavy duty industrial-type gas engine coupled to a compressor. The major characteristics of these units include low operating cost and a high degree of flexibility in some models by combining speed variation with cylinder unloading.

Natural-gas engine-driven reciprocating compressor units, condensing units, and complete water-chiller packages are available as factory assembled and tested systems in sizes from three to 375 tons. They can be used with remote direct expansion coils located in air handlers or ductwork and are adaptable to air-cooled condensing, evaporative condensing, or water-tower applications.

Among the benefits of natural-gas engine-driven machines is that of economy. They require from eight to 13 cu. ft. of 1000 Btu natural gas per ton-hour; no demand charges apply on natural gas in most areas. The cooling-tower pump can be driven by the engine, reducing electrical demand and operating costs. In addition, engine-jacket water and exhaust heat can be recovered and used for domestic-water heating, to provide boiler-water preheat, or as reheat on a dehumidification cycle at no additional cost for energy.

Gas turbine (in cabinet) powers low and high frequency generators supplying all McAllen High School electrical needs. Exhaust heat boiler behind turbine provides steam for heating and absorption cooling machine.



Other advantages claimed for the gas engine are that compressors last longer when driven by variable-speed engines, since they operate for a large portion of the time at 1000 to 1200 rpm instead of cycling on and off at a fixed speed. Compressor life is further extended by the virtual elimination of refrigerant liquid floodback, which tends to dilute the compressor lubricating oil, damages plates and bearings.

Gas-engine units give close humidity control. The typical engine-compressor unit varies both speed and cylinder loading and therefore cycles on and off infrequently. This means that speed and pumping rate change rather than suction pressure when the load varies, and the cooling-coil temperature is therefore held constant. the result is close humidity control through the full operating range of the unit.

The Total-Energy System

The most advanced development in the comfort air-conditioning field today is the gas "total-energy system" in which natural-gas energy is utilized to produce electrical power as well as cooling and heating requirements. The following discusses the methods whereby natural gas is employed to provide all three—using a natural-gas-fueled gas turbine or reciprocating engine as the prime mover in generating both conventional and high-frequency electrical power—and recovering exhaust heat from the prime mover to provide absorption cooling and heating. By generating power on the premises at reasonable cost and recovering enough heat for auxiliary heating or total refrigeration requirements, substantial savings in operations will result and more than pay for the additional equipment required for power generation.

All power cycles are for the conversion of fuel energy to more usable forms. The gas-turbine cycle produces both shaft power and economically recoverable heat energy. When this "total energy" conversion is considered, the gas turbine cycle with auxiliaries is the most efficient cycle commercially available today. Thermal efficiency of units so utilized may be as high as 75 per cent.

A number of benefits accrue from designs outlining the concept of a single fuel supply for schools, whether it be for total energy systems or a combination of systems, perhaps the most important of which is the flexibility permitted in design. Another benefit is economy through the qualification of lower rates by increased consumption of one fuel.

Gas company application specialists will be happy to assist architects and consulting engineers in the selection of the proper system. ◀◀

Note: More detailed descriptions of gas air conditioning and heating systems and other gas equipment, and economic comparisons, are available from the American Gas Association.

laminated wood and built-up roofing

KOPPERS COMPANY, INC.

Koppers Company, Inc., offers the school construction field a number of building products. Two of them, laminated wood and coal-tar pitch roofing, are covered in this article. First:

LAMINATED WOOD

The demands of modern school design require materials that not only have structural integrity but are adaptable to varying educational needs. Laminated wood provides the architect with a tool to meet these requirements. Let's look at some of the areas which must be considered in today's school architecture.

Structural

Laminated wood is ideally suited to the modern one-story concept of school construction. Its high strength to weight ratio makes it particularly adaptable for clear span design—whether it be a 40-foot classroom or a 300-foot college fieldhouse. Through the use of modern adhesives and gluing techniques, it is possible to "shop grow" timbers of any size that are as reliable as any structural material known.

The one-story type school provides maximum fire safety for the occupants through its easy access to the outside. While most school fires originate and are supported by room contents, laminated wood when under attack by flames loses its structural strength very slowly. This loss is in direct proportion only to the amount of cross section destroyed. As the wood chars, a natural insulator forms to further retard strength loss. This allows firemen valuable time to locate and extinguish the source of the fire without the danger of sudden collapse at elevated temperatures characteristic of other structural materials.

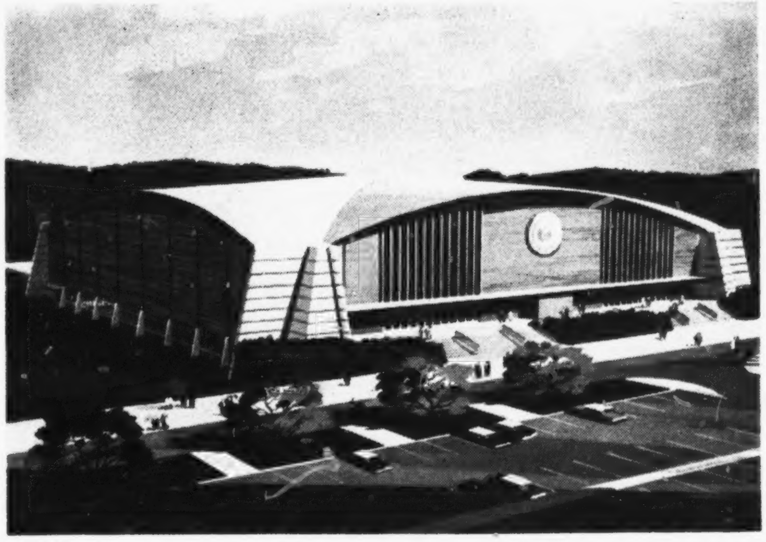
Strong, yet resilient, laminated wood can withstand short term loads such as high winds and snow loads without any permanent deformation.

The basic structural system of laminated wood is also the finished interior—no need to add expensive and artificial concealments as necessary with other framing systems.

Flexibility

Since laminated wood structural members are custom made, a large variety of shapes—such as high and low pitch V arches, curved and straight beams and trusses —are available to allow the architect complete freedom of design and site adaptation.

Laminated wood construction allows the designer the wide latitude in creating forms adapted to and expres-



STRENGTH—Eastern Kentucky State College Coliseum is built with world's largest laminated arches. Main diagonal span of the double cross-vault design is 308'-3½", rises 78' above floor. This is structurally unique because entire weight of overhead enclosure is carried by only four laminated arch segments resting on concrete buttresses. Non-structural material may be used for side wall enclosures as they carry no roof loads.

VERSATILE—New Holland, Michigan, campus-type high school is decentralized, with each building serving a distinct purpose, yet flexible enough for multi-use. Architect selected laminated wood structural arches and beams for the school's fieldhouse, library, commons areas and classrooms because it provided the "warm, non-institutional look" that Holland wanted—at low overall cost of $13.70 per sq. ft.

sive of the function and intended building use. The laminating process permits the shaping of the individual structural members with ease, without the need for devising complicated splices and numerous connections required by other materials. There are no limitations on the arrangement of classrooms, corridors, recreation areas and other units.

Post-free construction with laminated wood results in highly flexible interior space that allows easy alterations as required to meet changing needs. Non-load bearing partitions and movable walls can be installed quickly and economically. Laminated wood is light weight and easily incorporated into the structures without special trades required.

Environment

In modern school design, the choice of a building material can psychologically aid or detract from the learning process. The warmth and familiarity of wood creates an atmosphere that is conducive to learning. The pleasing color and interesting grain patterns of wood are a happy contrast to the harsh and monotonous appearance common to other materials. Since laminated wood can be stained, painted or left natural, it blends with any color scheme or decor.

One-story schools of laminated wood construction compliment the area in which they are erected. The wide versatility of wood construction can result in a structure that is in keeping with any architectural style.

Maintenance

Maintenance costs of laminated wood schools are the same—or less—than schools constructed of other materials. The variety of proven paints and varnishes available today provide surfaces which are easily maintained and long lasting. Where severe conditions exist that may be conducive to decay and insect attack, preservative treatments are available to provide permanent protection. Treatments can be obtained that leave the wood completely paintable, clean and odorless.

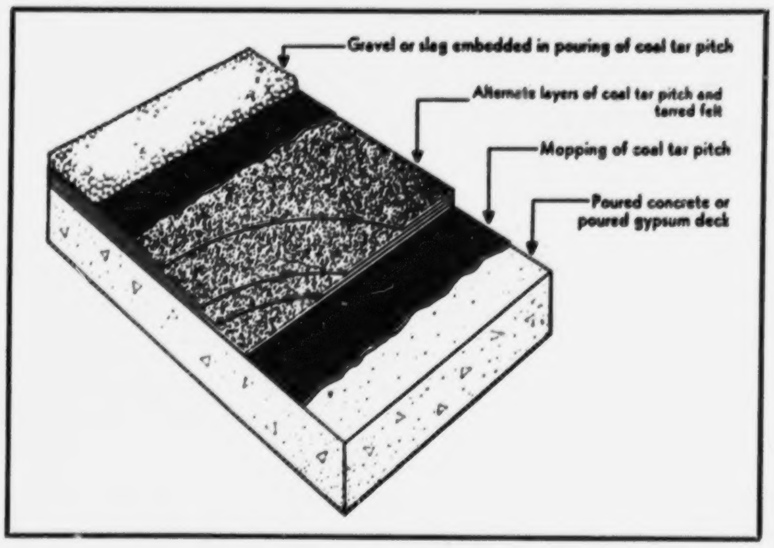
In addition to the initial construction savings and low maintenance costs, laminated wood structural systems can result in reduced heating and air conditioning expenses because of its excellent insulating values.

Now let's talk about:

BUILT-UP ROOFING

Modern trends in school construction make increasing use of one floor design. This type of construction, with its inherent advantages of freedom of design, economy of construction and functionality, lends itself perfectly to the requirements of present day architecture. A natural result of this type of design is the low slope or "dead level" roof.

In such roofs, the importance of waterproofness is paramount. This waterproofness is best provided by building up alternate layers of tarred felt and hot coal-tar pitch. The built-up roof is then covered with an extra heavy top pouring of pitch into which is embedded either slag or gravel. The slag or gravel acts as an armor coat to protect the membrane against hail, driving rain, sleet, snow, etc.


Gravel or slag embedded in pouring of coal tar pitch
Alternate layers of coal tar pitch and tarred felt
Mopping of coal tar pitch
Poured concrete or poured gypsum deck

Poured concrete deck construction

Construction of a built-up roof naturally starts with the deck. There are basically seven types of decks that are most commonly used: wood, wood fiber, poured concrete, lightweight fills, precast concrete slabs, poured gypsum and metal.

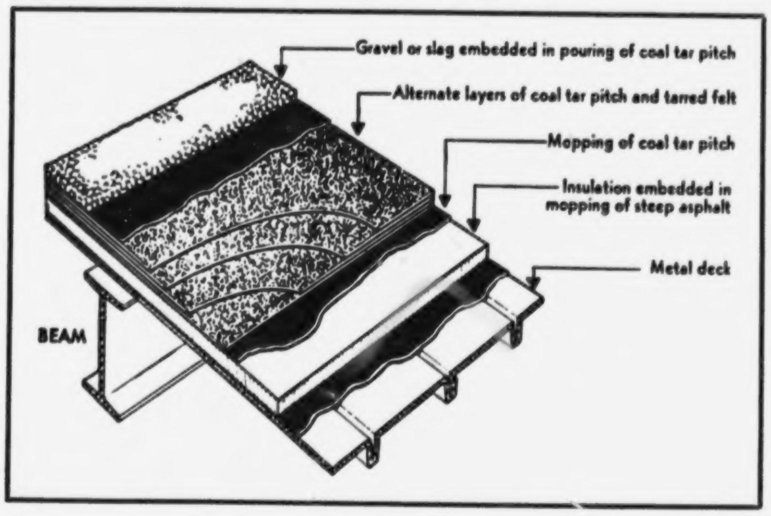
All decks should be installed in accordance with the deck manufacturer's specifications. They should be properly graded to drain outlets and should be clean, smooth, completely dry, rigid and free of debris. Any deck defect should be corrected before application of the roofing. To avoid future problems, all projections or openings in the deck should be completed prior to application of the roofing.

Insulation

Approximately 80-85% of all flat roofs are insulated in some form. Regardless of the type specified, all roof insulation should be dry when installed and attached securely to the deck. It should not be applied over anything but a completely dry substrate, nor should it be applied when subsequent traffic from roofing crews, other trades, and equipment may damage it. To prevent possible moisture absorption, no more insulation should be laid at any one time than can be protected by pitch and felt in case of sudden weather changes.

Insulation used should have high compressive strength and a low rate of absorbency of the bitumen.

Metal deck construction with insulation


Gravel or slag embedded in pouring of coal tar pitch
Alternate layers of coal tar pitch and tarred felt
Mopping of coal tar pitch
Insulation embedded in mopping of steep asphalt
Metal deck
BEAM

Vapor barriers are normally used where high humidity conditions are to be expected inside the structure for various reasons. The desirability or necessity for a vapor barrier depends on many variables, such as climatic conditions, soil conditions and building occupancy.

Prior to application of the first layer of felt, a mopping of coal-tar pitch should be applied. Coal-tar pitch is the actual waterproofing agent in a built-up roofing system.

Prolonged contact with water is a condition almost impossible to avoid on flat roofs. Coal-tar pitch has a natural resistance to water, and even air and water vapor penetration. A tight molecular structure enables coal-tar pitch to permanently withstand water penetration and further prevents oxidation of the roof surface.

Self-Healing Ability

Another characteristic of coal-tar roofing is its permanent self-healing ability. Alligatoring and hairline cracks, common to most materials, eventually cause damage to the roofing membranes. Coal-tar pitch has a property known as "cold-flow," which automatically corrects these conditions before serious damage takes place.

Roofing felts should be applied so that the direction of the flow of water is over and not against the laps. The plies of felt should be broomed or pressed into the hot pitch and laid without wrinkles, buckles or kinks, so that the finished roof is free from pockets or blisters.

The widths of felt are laid shingle fashion, not only because this method produces a stronger membrane, but also because it makes possible construction of a roof of any desired number of plies in a single progressive operation. This is accomplished by varying the widths of the edge laps. Three-ply roofing, for example, is achieved by lapping each width approximately two-thirds over the preceding width; for four plies, a lap approximately three-fourths the width should be allowed.

As mentioned earlier, the top layer of felt should be covered with an extra heavy top pouring of pitch with either slag or gravel embedded.

Joints, Drains, and Flashing

Proper performance of a built-up roof depends on many details in addition to the membrane construction. Three of the most important are expansion joints, roof drains and flashing.

For the protection of the roofing system against splits caused by expansion and contraction, an expansion joint should be installed: (1) on large roof areas at least 200 feet in each direction; (2) at all places where the structural supports and roof assembly change direction; (3) where type of deck material changes; (4) where control, expansion, or contraction joints are provided in structural steel, deck material, or deck system.

Another factor which has a direct bearing on the proper installation of built-up roofing is the location and spacing of roof drains. A sufficient number of roof drains should be installed with metal flanges to insure watertightness and should be located so as to carry water away from the area they serve.

Probably the most important consideration in proper application of a built-up roof is flashing. Its importance cannot be stressed too strongly—the value expected of a good roofing membrane will be completely lost if inadequate or poorly installed flashings are employed.

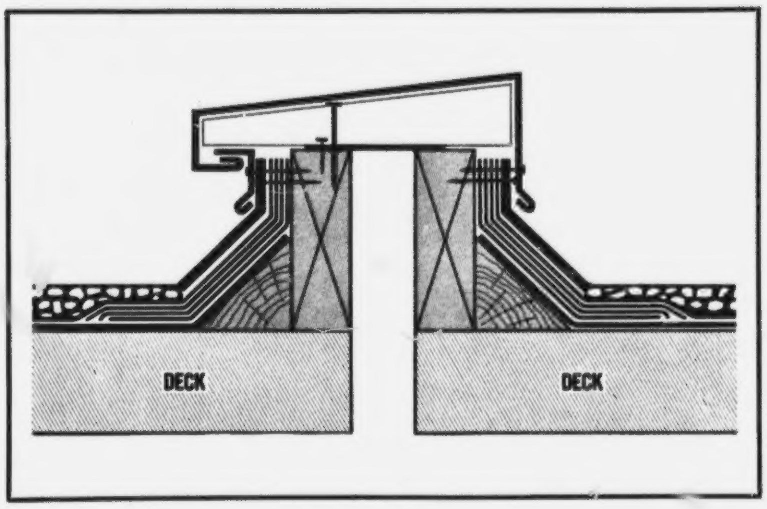
Flashings must be installed at all points intersected by vertical planes in the structure, such as at walls, parapets, skylights, ventilators and other projections.

Other Flashing Factors

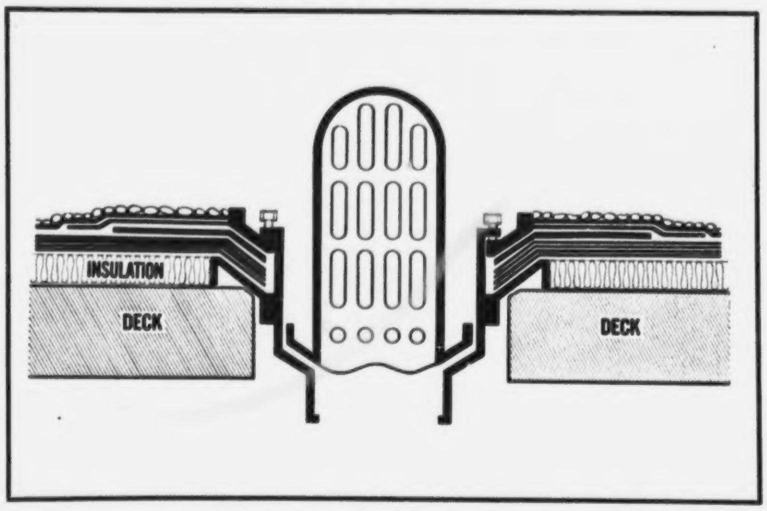
Flashing is not only affected by expansion and contraction of the material itself, but also by the expansion and contraction of the construction to which it is attached. In addition, the effects of disintegration and its resulting harm to the flashing adhesion must be taken into consideration since this action will eventually separate flashing from the wall. For this reason it is particularly important that the top edges of the flashing be protected by counterflashing which will insure a diversion of the water away from any opening that might develop between flashing and wall.

The above are only a few of the many factors to be considered in the design of a built-up roof. Proper specifications and detailing by the architect, quality materials for all components of the roof, and proper application by a reliable roofing contractor can insure a school building of many years of trouble-free roofing. ◀◀

Expansion joint detail



Typical drain detail



kimberly: a total learning environment

EDISON ELECTRIC INSTITUTE

For more years than architects care to record, school design has been based on the simple principle of natural light and ventilation. The school planner has had a problem: when artificial lighting was meager or nonexistent, conventional thinking about windows and light, cumbersome heating systems, and other environmental factors has dictated the way in which each classroom's space requirements were allocated and designed.

According to educators, the ideal classroom environment is one in which lighting is high but not distracting, ventilation provides adequate outside air to remove odors but prevents drafts, inside temperatures are controlled in each room individually to satisfy requirements, and noise levels are held to a minimum. From a practical standpoint, the ideal classroom must be flexible in terms of teaching techniques and changing enrollment. Above all, the construction of such classrooms must be economical.

Low Comparative Costs

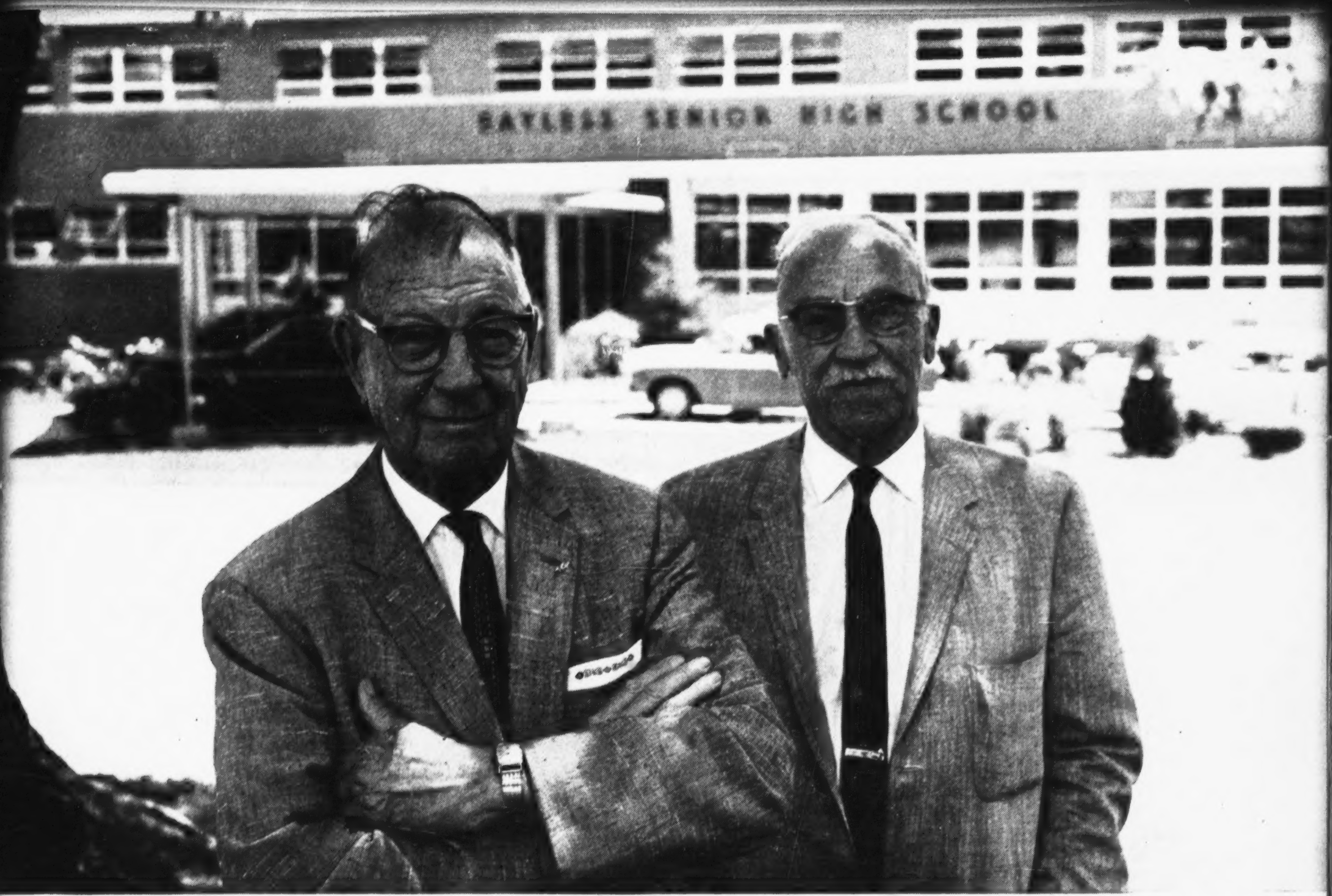
The prototype of this perfect school is now setting the pace for the nation in Kimberly, Wisconsin. An operating reality since September 1963, Kimberly High School reflects the goals of far-seeing educators and architects. At a cost of $12.46 per square foot, the Kimberly School board has built a 133,487 sq. ft. building that uses electricity for all energy requirements, including air-conditioning, heating, air-cleaning and high level lighting.

Heat Pump Savings

The "extras" in the Kimberly High School actually permitted great savings in the overall construction of the building. With an electrical air conditioning system the school has less need for windows for ventilation. By reducing the number of windows, designers were able to create a compact school instead of the more prevalent sprawling finger-type building. Perimeter walls were greatly reduced, allowing for greater use of less expensive interior partitions. Savings in construction and plumbing work made possible by compact design more than paid for the cost of an air conditioning system.

Heart of the new high school is its "heat pump." This versatile device permits the air conditioning system to provide simultaneous heating and cooling. The heating and air conditioning design of the Kimberly School is inter-related with the lighting system as well. The heat

Kimberly High School in Wisconsin, one of the nation's most modern and scientifically designed schools, is making heating and cooling history with heat pump system.



"IN PROFESSIONS LIKE OURS, keeping up with modern developments is a must," say Ernest Friton (left) and Ralf Toensfeldt. "That's why we've started to use total electric design for new schools like this."

"IN ALL OUR YEARS OF PRACTICE, NO ADVANCE WE'VE SEEN TOPS TOTAL ELECTRIC DESIGN"

Ernest T. Friton, architect, and Ralf Toensfeldt, consulting engineer, tell how specifying total electric construction for the Bayless School District's new Senior High School in Affton, Missouri, allowed them to cut costs and simplify design

"Between the two of us," Ernest Friton reports, "Ralf Toensfeldt and I represent close to a full century of engineering and architectural experience. And in all that time, no new development has impressed either of us any more forcibly than this idea of total electric design.

"First of all, you immediately start out ahead of the game when you can heat your building the same way you light it, and work with one source of energy instead of two or more. Also, with electric heating your control systems are extremely flexible and uncomplicated, and construction is faster and less expensive.

"In this Bayless school, for example, the use of electric heating allowed us to eliminate such high-cost items as trenching, stack and boiler room construction, and steam piping or ductwork. This alone resulted in initial cost savings of better than $35,000—together, of course, with a more efficient building layout.

"Total electric design for schools also turns out to be equally attractive from the client standpoint. According to the Bayless School Board, operating costs have been remarkably low, and maintenance and repairs on equipment, for all practical purposes, have been non-existent."

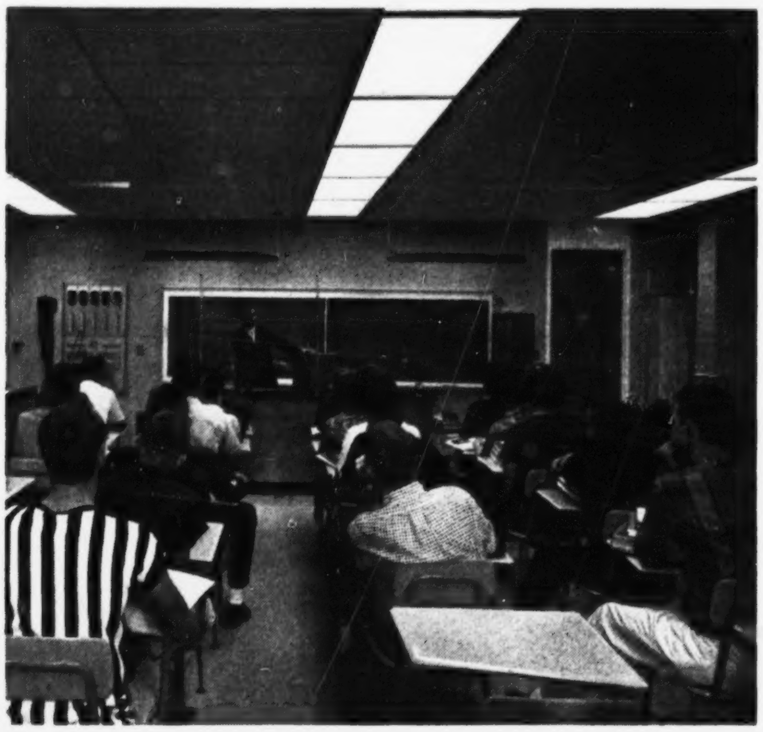
For architects and engineers, total electric design offers the modern method for combining heating, cooling, water heating and lighting into one efficient operation using a single source of energy. If you are interested in how it can help you in the design of institutional, commercial and industrial buildings, contact your local electric utility company. They will welcome the opportunity to work with you.

BUILD BETTER ELECTRICALLY

Edison Electric Institute, 750 Third Avenue, New York 17

"SAVINGS IN SPACE are another important advantage of total electric design for schools," points out Ralf Toensfeldt. "With electric heating, for example, this one small control area replaces a full-sized boiler room."

In Kimberly School library, folded planes of the ceiling give unusually soft lighting throughout the entire area. Lighting fixtures fit into the pattern, but are also arranged to provide an even 100 fc in the room and to wash most of the vertical surfaces with light.



In typical science classroom, absence of windows permits ideal arrangement of lab tables. Students can easily see demonstrations whether seated or working at tables. Supplementary lighting at chalk board helps to direct attention to this area. Typical lighting level is 150 fc.

pump uses the heat given off by fluorescent lighting and body heat of the students to furnish nearly all the heat needed in the school.

The special heat pump system was installed at a cost of $180,580—more than just an ordinary heating system would have cost. But by using a heat pump, a saving of approximately $332,875 was made in general construction, electrical work, plumbing and painting. Net savings amounted to more than $150,000. Air conditioning, then, was not an added expenditure but rather a means of creating overall savings.

An annual co-efficient of performance exceeding four is realized by transferring the internal heat gains from the interior of the building to exterior rooms. When heating requirements of the building are met, 120 degree water from the condenser is diverted to two 12,200 gallon basement tanks. Heat is also extracted from exhaust air, well water, and when the school is unoccupied, from the storage tanks. Occupied internal heat gains are sufficient to balance total heat losses when outside temperatures are as low as 18°.

According to school authorities, the heat pump has performed without mishap. Some rooms in the building have not varied more than 1° since the school was first occupied in September, 1963. The system is cooling some rooms and at the same time, warming others.

Lighting

Exterior classrooms generally have fluorescent lighting levels of 150 footcandles. In these classrooms students face away from the window to avoid glare and outside distractions. Variations in quality, quantity and light direction have been provided. For example, in the drafting-mechanical-drawing room in the industrial arts department, lighting levels are 200 footcandles of evenly distributed illumination—superior to that found in most industrial and manufacturing plants. At Kimberly, all students receive equal illumination that is glare-free. All classroom lighting meets the recommendations of the Illuminating Engineering Society.

Dramatic Results

Total space conditioning of the Kimberly School has had dramatic results. Teachers report that constant temperatures have lessened fatigue and have enabled their students to remain attentive. The high lighting level, which ranges between 100 and 200 footcandles, and interesting wall colors, provide an atmosphere of spaciousness.

The compactness of the entire school structure also means that less time is consumed by the students moving from room to room. The same compactness makes administration a simpler task. Shorter plumbing and electrical runs are also an end result of Kimberly School design. Above all, Kimberly is a healthy school. Electronic filters remove dirt from the air as it enters the building. The clean atmosphere also means less maintenance. Kimberly officials say that in the future, as enrollment grows, the school will be easy to expand.

This approach of providing a total learning environment is gaining acceptance in new school design. Prior to Kimberly's construction, the heat pump was thought suitable only for areas below the Mason-Dixon line. In an area of 7690 degree days Kimberly School's performance has proved that effective heat pump operation can take place in extreme northern climates.

The real effect of this new approach to school design, however, has been to provide students with an atmosphere that encourages the learning process—a total learning environment. ◀◀

daylight as main illumination source

Libbey-Owens-Ford Glass Company

One of nature's greatest creations is natural light. It has been used by man since his beginning and always has served him well. During the process of man's becoming aware of his environment and attempting to improve it, he continually has developed better means of utilizing natural light.

Daylight as a high quality and quantity type of illumination always has been recognized as an important factor in properly and effectively lighting schools, because it is both economical and extremely effective in illuminating reading and writing tasks.

But it is only in recent years that measuring the benefits of daylight has come of age. Replacing the time when lighting of classrooms often was only a haphazard guess is new knowledge from research by scientists in the illumination engineering field. It is this research which has uncovered just *how* important daylight is in designing quality lighting systems economical for school districts, and allowing the student to perform at his greatest potential.

For example, consider these statements on daylight, and how they can enable a school to be built at lower costs:

- Lighting and air conditioning costs most often are lower in schools using daylight from a side window wall as the primary light source, and artificial lighting as a supplement, than in schools using overhead lighting only.
- The original cost of adequately illuminating desks by overhead lighting only is often higher because, when no daylight is used, a greater number of luminaires must be installed to meet minimum classroom lighting standards.
- Operating costs also are lower when lighting is primarily by a side window wall, rather than by overhead luminaires alone. Any extra cost of maintaining a side window wall is more than offset by extra costs of operating additional luminaires needed when daylight is not used.
- Air conditioning costs may be considerably lower in a building with sidewall daylighting. When only overhead artificial lighting is used, the greater heat of the additional luminaires may require more air conditioning equipment, which is more expensive to install and maintain.

These are conclusions drawn from extensive research at Southern Methodist University by Professor J. W. Griffith, internationally known authority on daylighting. He has been associated with Libbey-Owens-Ford Glass Company for 17 years in studies of daylighting.

Professor Griffith has evaluated not only the economic value of daylight, but also its effectiveness in illuminating the visual tasks which comprise so much of the educational process. His study of daylight's effectiveness produced these conclusions:

Schools using daylight from a side window wall as primary source of light, and artificial lighting as a supplement, have more effective illumination than buildings with overhead lighting only. In fact, about one-half as much illumination is needed if daylight walls are used as the primary source. Most ordinary reading and writing tasks require twice as much illumination if it comes only from overhead sources rather than sidewall lighting.

A more detailed examination of these two research projects, and how Professor Griffith arrived at these conclusions, further emphasizes the importance of daylight's role in providing an effective yet economical work place for learning.

In studying lighting costs and their influence on other school costs, Professor Griffith considered both incan-

Daylight from a side window wall provides effective illumination in this study hall at Ithaca Senior High School, Ithaca, N.Y.

Daylight from side window wall, supplemented by overhead luminaires, provides effective illumination in Loy Norrix High School, Kalamazoo, Mich.

descent and fluorescent lighting as exclusive sources of illumination and also in combination with natural daylight.

To analyze the problem, a space 30 feet long and 20 feet wide, with a ceiling 10 feet high, was used. The ceiling was painted white and the walls had a 50 percent reflectance. Visual tasks were determined to require from 70 to 100 foot-candles. It was assumed that the room would be used five days a week or approximately 2,500 hours per year.

Next, the types of lighting had to be determined. To meet the brightness ratios and limitations recommended by the Illuminating Engineering Society, incandescent, fluorescent and daylight were chosen.

For the required illumination, a 300-watt incandescent silver-bowl luminaire with a concentric ring louver was used and the fluorescent unit was a 4-40 watt rapid start commercial luminaire, with 45 degree by 45 degree louvers. The daylight was provided by a window wall 30 feet long and 7 feet from sill to ceiling, covered by operable Venetian blinds.

Before the analysis began, it was necessary to determine the number of units of each light source required to provide the specified illumination. This was done by using the lumen method of artificial lighting prediction for the electric alternates and the lumen method of daylight prediction for the daylight alternate.

To provide the minimum 70 foot-candles required by a single source, 17 fluorescent warm white luminaires were needed. And when fluorescence was the only source of light, the more desirable deluxe lamps were recommended, requiring 24 luminaires.

Because of excessive heat, it was impractical to supply 70 foot-candles of illumination from incandescent lighting. Since daylight in a school varies with outside conditions, the illumination in the model room was computed for the low condition, or 500 foot-candles of light on the window.

The Venetian blinds were adjusted to a 45 degree angle to shield out the sun on clear days and were raised for overcast conditions. The average illumination from daylighting can, if desired, be more than 100 foot-candles, or it can be reduced by closing the blinds. For this economic comparison, however, illumination within the room was determined to be 70 foot-candles or more, a figure which numerous studies have proved is conservative.

When the lighting sources were integrated, 70 foot-candles of daylight and 30 foot-candles of artificial light were used to provide the required illumination. The electric lighting in this situation is assumed to be used only 1,000 hours per year (instead of the 2,500 when used alone) as a supplement to daylight and for night-time janitorial use.

After analyzing the various lighting systems, it was found that the most economical was a combination of daylight and standard fluorescent lamps, costing $213.68 annually. A daylight and incandescent system cost $229.67 annually, followed by fluorescent only, $395.81, and incandescent only, $621.61.

Lighting costs alone do not tell the complete economic story when an illumination system is being designed, for where there is light there is heat. Heat from light sources affects the cost of air conditioning a building, and this factor must be taken into consideration in determining which lighting system is most economical.

To compare the heat gain and loss for the various lighting alternates, it was necessary to study rooms with both an east and west exposure. All things being equal, a school building with only one glass exposure would be oriented north for economic design of the air conditioning system. However, many schools have two or more glass exposures and the building which has large glass areas facing both east and west has a more severe sun heat gain problem than one with north-south orientation.

For the heating-air conditioning phase of the study, two classrooms were set up with the same interior design as the one described previously. Calculations were made with the rooms under the most severe conditions possible—that is, one with an east and the other with a west orientation, with the sun on the window areas of the building.

The summer design temperatures were taken at 95 degrees F. outside and 80 degrees F. inside, with the winter design temperature at –5 degrees F. The number of heating degree days was set at 5,000 and the equivalent full load operating time for air conditioning was 1,000 hours in the daylighted designs and 1,250 for the artificial lighting with no daylight. Peak heat load was computed at 4 p.m. on July 23, using regular plate glass and Venetian blinds adjusted to 45 degrees.

Heat loads and losses for the various combinations were computed, using standard techniques taken from the *Heating, Ventilating, Air Conditioning Guide* of the American Society of Heating, Refrigerating and Air Conditioning Engineers. Cost of an extra ton of air conditioning to overcome natural and artificial lighting loads was assumed to be $700, and heating costs were set at $1 per 1,000 pounds of steam at 1,000 BTU per pound. Air conditioning operating costs were based on 1.25 kilowatts per ton.

Calculations show that the total first cost of extra air conditioning for the two classrooms was $1,561 for each of the two combination daylight and artificial systems, and $1,799 and $2,513 respectively for the two artificial lighting systems. The annual energy cost for extra air conditioning due to heat gain was $74.76 for daylight and standard fluorescent; $82.91 for daylight and incandescent; $100.40 for standard fluorescent with no daylight; and $140.23 for deluxe fluorescent with no daylight.

To arrive at the comparative uniform annual cost due to heating and cooling, the following were added: (1) the total uniform annual cost of air conditioning due to lighting, and (2) the uniform annual cost of heat loss through windows or masonry walls. From this figure was subtracted the uniform annual savings in heating due to artificial lighting load. These annual heating and cooling costs were: (1) standard fluorescent only, $378.02; (2) daylight and incandescent, $352.01; (3) daylight and standard fluorescent, $356.31; and (4) deluxe fluorescent only, $508.71.

In the final analysis, with illumination, heating and cooling costs figured, it was found that the two lighting systems using daylight supplemented with artificial light were most economical. The total comparative uniform annual costs were: (1) daylight and standard fluorescent, $783.67; (2) daylight and incandescent, $811.35; (3) standard fluorescent, $1,508.02; and (4) deluxe fluorescent, $2,098.71. These figures are combined costs for the east and west exposed areas.

It is quite obvious that economic analysis of the overall design of lighting is necessary for satisfactory results.

The economic conditions in each locale vary enough to require a cost analysis with each different building.

In determining the effectiveness of a type of illumination, Professor Griffith researched the quality of light from a side window wall and from overhead sources on visual tasks. He studied the effectiveness of each type of lighting on tasks, rather than merely how much light each system produces on a given task. These studies were carried out in a scaled model room.

He measured the contrasts of tasks utilizing pencil, ink and ballpoint pen, as well as tasks involving typed material and print. Simulated daylight tests were made with illumination from an overcast sky and uniformly bright sky, as well as sun when Venetian blinds were set at 45 degrees. He also tested overhead lighting from a luminous ceiling and from fluorescent luminaires.

The tests showed a considerable loss of contrast from reflected glare on tasks lighted only by overhead systems as compared to tasks illuminated only by a side window wall.

Four basic factors in seeing, Professor Griffith notes, are (1) time, (2) size, (3) brightness and (4) contrast. Seeing is made more difficult by reducing any one of these factors. To maintain equal visibility any loss of vision must be made up by changing one or more of the other factors. But the professor's research showed additional illumination cannot be obtained by increasing the brightness of the luminaires without increasing the loss of contrast at the task.

The reason you get a loss in contrast is quite simple, Professor Griffith explains. For example, in the pencil task, paper reflects more of the diffuse or uniform light than the pencil mark reflects. This difference in brightness is the contrast which allows a person to see the writing on the paper.

The pencil mark and the paper also have what is termed specular reflectance, which is the reflected brightness of the lighting source. Since the pencil has a higher specular reflectance than the paper the veiling reflection of the light source on the task is brighter for the pencil mark than for the paper, Professor Griffith points out.

This means that the specular reflections work against the diffuse reflections in producing the total contrast the eye sees. In other words, as the overhead lighting increases in brightness the contrast becomes less for any given level of illumination.

Daylight coming to the task at low angles from side windows does not reflect specularly into the student's eyes as much as the overhead light, Professor Griffith notes. Thus the contrast is higher for most school tasks when the major source of illumination is from windows in the sidewalls.

In his tests, Professor Griffith used a one-twelfth scale model simulating a room 30 feet by 30 feet with a 10-foot ceiling. The model simulated a sealed window wall 30 feet long by 6 feet 9 inches high with a 42-inch sill.

In summarizing the results of his test, Professor Griffith said the gain in task contrasts when sidewall lighting is used would indicate "the need for changing illumination recommendations to specify different levels depending on the location of the major source."

For good vision it doesn't matter whether the sidewall lighting comes over the left or right shoulder. Either provides good illumination for reading, says Professor Griffith. ◀◀

prefabricated metal curtain wall

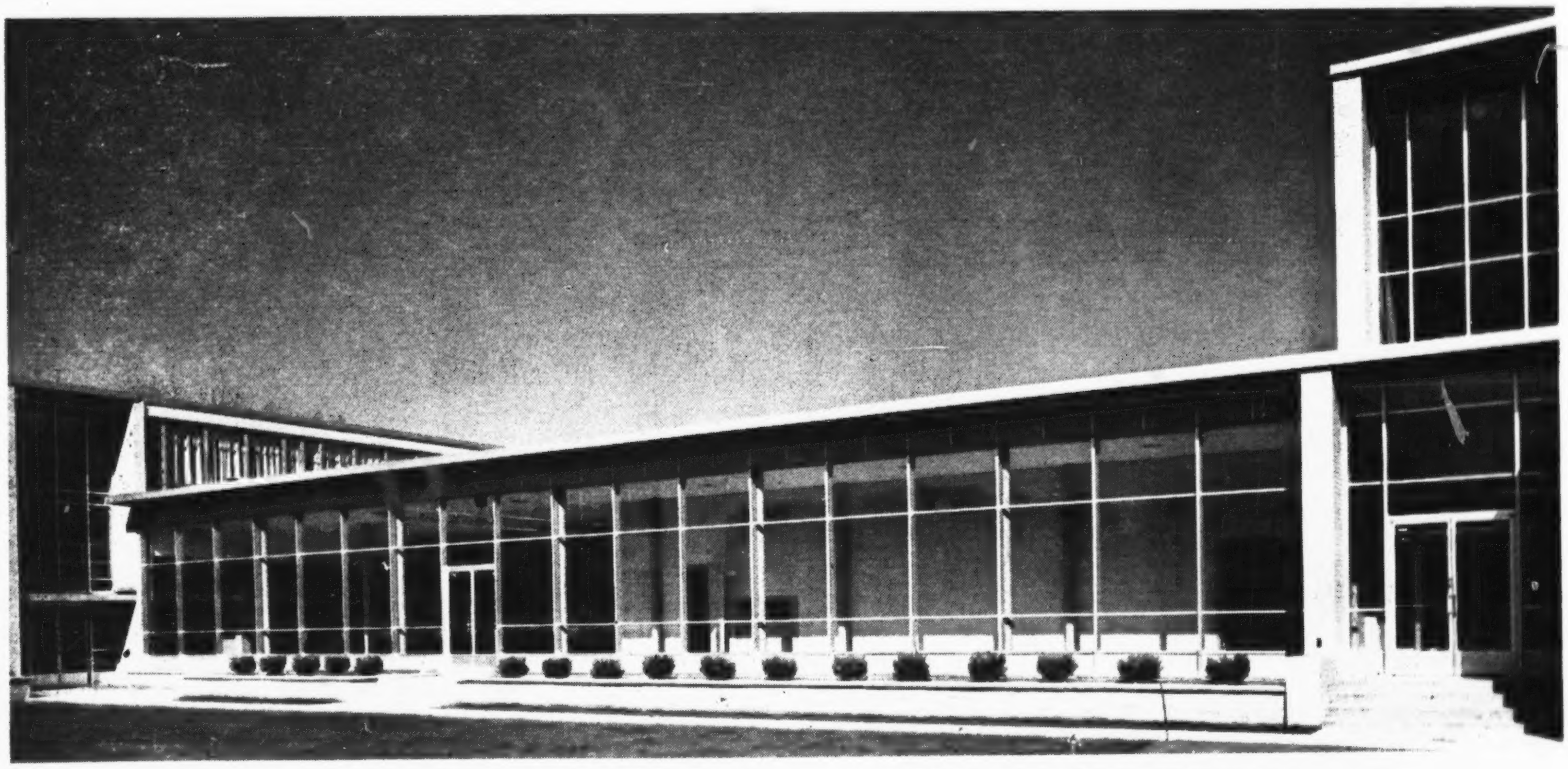
Kawneer Company, Inc., a subsidiary of American Metal Climax, Inc.

Time costs money, goes the administrator's adage. But time, too, can save money when scheduled most efficiently. Take modern-day school construction for example. Proper scheduling of the various trades to meet a critical timetable is a major problem for the general contractor, and completion before the deadline is critical to all concerned. In this respect the use of Unit Wall for school construction can be of considerable help.

Prefabricated metal curtain wall sections, made to the architect's modular requirements, are ready for rapid installation as soon as they arrive at the job site. Unit Wall jobs, therefore, will close-in faster, allowing the finishing trades to go to work at an earlier date.

Synchronize Your Schedule

Unit Wall construction techniques benefit in other ways, too. You "get the jump" on a time problem by compressing your work schedule back to the Kawneer factory. Even before the foundation of your school has been dug and poured, construction of the aluminum Unit Wall has begun.



Factory fabricated aluminum Unit Wall systems can reduce job-site time and construction costs.

Unit Wall being assembled at factory (left).

Unit Wall going up (right).

Fabrication in controlled factory assembly lines by experts insures superior workmanship and exceptional appearance. And, factory fabrication also eliminates a great portion of the construction time normally consumed by traditional construction methods on the job site.

Tongue and Groove Installation

Kawneer curtain wall is made for easy, low cost installation. Designed in sizes that are easily handled by two workers, units slip into an aluminum perimeter and are mated together at the split mullions through tongue-and-groove construction techniques.

Long, continuous runs of pre-assemblies can be installed without delays since there is no slowdown in the closing-in process in order to wait for other trades to complete their portion of the curtain wall. Vents, glass and insulated panels go in together as integral parts of the curtain wall unit.

Multi-Purpose Features

Split mullions, important to the fast installation of Unit Wall, also act as thermal expansion joints. Kawneer's Unit Wall design accommodates thermal movement at *each* vertical mullion, with no special design provisions required.

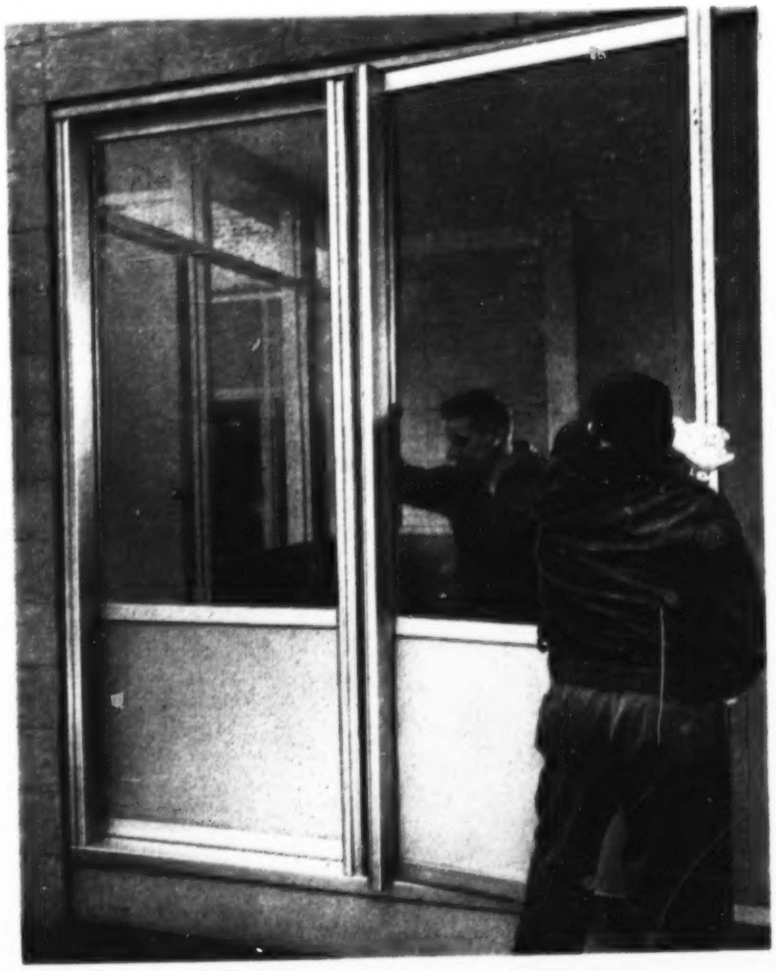
Unit Wall systems utilize gasket weathering at each mullion to minimize air infiltration and eliminate water leakage problems. This weathering maintains its effectiveness even after years of thermal movement.

In the mullion detail of Kawneer Unit Wall 1200 (See Figure 1), both the split mullion feature and mullion weathering are illustrated.

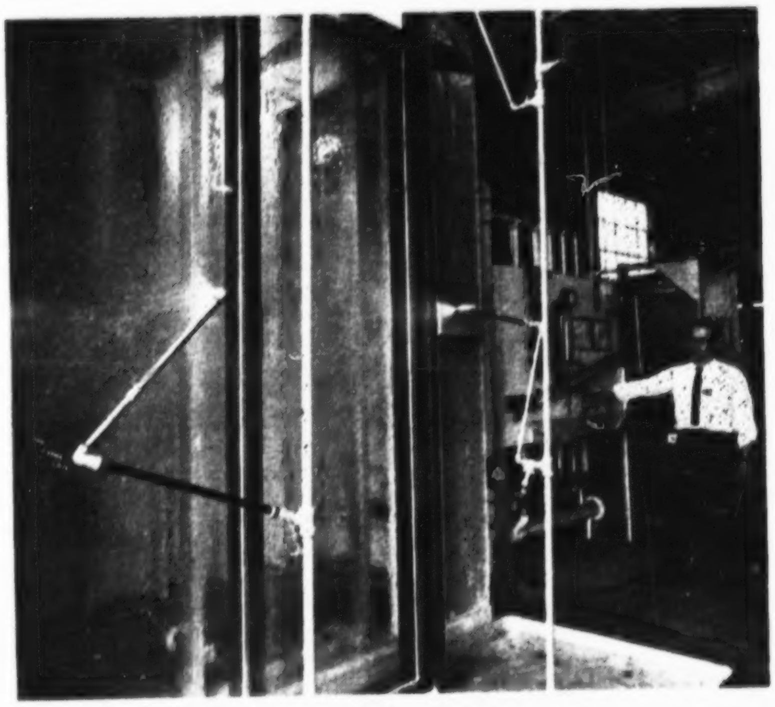
Engineered for Performance

In the development of new Kawneer products, major emphasis is placed on product performance against air and water infiltration. Using a static pressure chamber, Kawneer engineers regularly subject Unit Wall and Sealair Window products to rigorous performance tests. Capable of simulating wind and rain equivalent to hurricane conditions, these tests measure a product's structural performance and resistance to air and water infiltration. It was during routine static tests that Kawneer engineers developed a principle for greatly improving the performance of wall systems and window products—it is called Pressure Equalization.

Window leakage long had been a problem in school construction until the development of the new high performance Sealair Vents in Unit Wall. The vents work on the following principle: during a storm the air pressure within the building is considerably lower than on the outside. This pressure difference can draw water into the sill area in a siphon-like action. If not prevented, a water head builds up and overflows to the inside. But, the unique Kawneer Pressure Equalization Slot (indicated by the arrow in Figure 2) prevents the pressure difference in the sill, and produces superior performance in Sealair operating vents. For example, in certified tests Sealair Projected Vents did not leak when



Easy tongue and groove installation.



Static pressure chamber performance test.

Figure 1

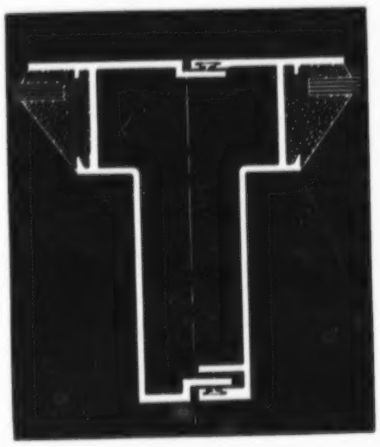
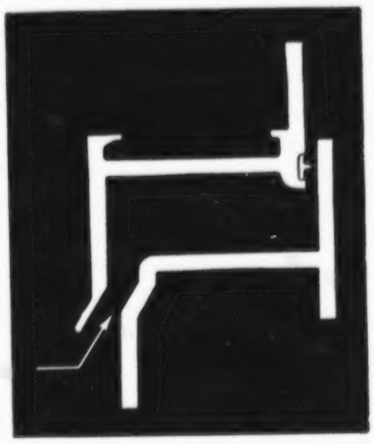
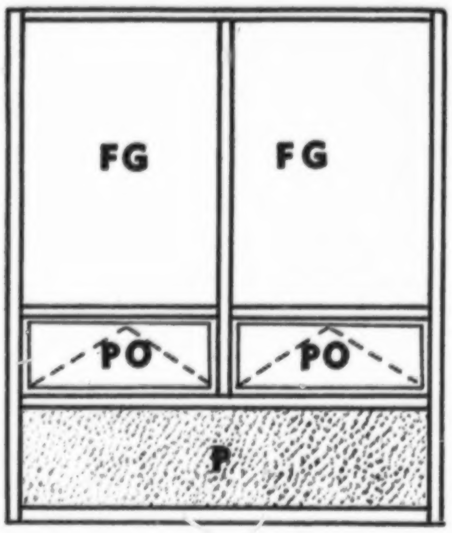
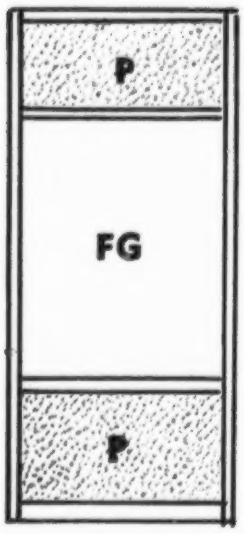
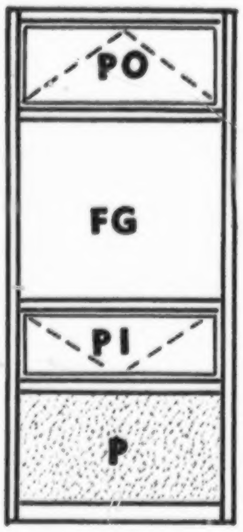


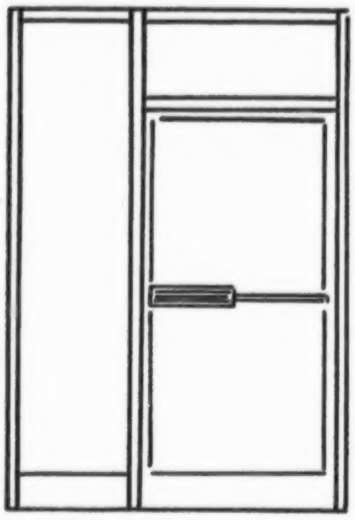
Figure 2

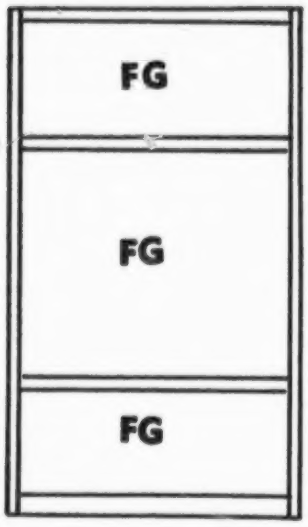












subjected to winds of 90 miles per hour accompanied by an eight-inch rainstorm.

Complete Design Flexibility

Schools can take on a bright, modern look when designed in Unit Wall. Design possibilities are many and varied. Combinations of glass, colorful insulating panels, insulating glass, aluminum doors and operating vents enable the architect to design with total freedom and integrity. The sketches shown in the column at left demonstrate a few of the many variations of units in the system. Identification key for the sketches:

P—Panels
FG—Fixed Glass
PO—Project-Out Vent
PI—Project-In Vent

What About Future Expansion?

To accommodate future expansion of existing Unit Wall schools, entire wall units can be removed, and used again, on the new addition. Non-fading, long-lasting porcelain insulating panels and glass never show their age. Unit Wall on an old school and the new addition will have the same uniform appearance.

With Unit Wall you have freedom to change plans, too. For instance, should it become more desirable to have a windowless audio-visual center instead of a bright, naturally lighted classroom, panels can be substituted for glass in the Unit Wall System.

For these reasons, the economy of Unit Wall continues long after the initial construction has been completed.

Enhance Appearance and Reduce Maintenance

A new touch of beauty, Permanodic Hardcolor finishes, can add richness and durability to your next school design. Permanodic Colors in warm tones of Light Bronze, Medium Bronze and Black, are the practical answers to new school designs using Unit Wall or Sealair Windows. Besides their unusually attractive appearance, products with Permanodic Color finishes benefit a school because they are extremely durable and scratch resistant. Actually, Permanodic finishes are Architectural Class I finishes that are much more dense and abrasion resistant than conventional finishes commonly given aluminum building products. The Permanodic Color process gives color in the metal without dyes, and as a result the finish will not fade or chip. *There is no re-painting or other costly yearly maintenance with Permanodic colors.*

For More Information

Kawneer Company produces a complete line of aluminum curtain wall, commercial and monumental aluminum windows, aluminum doors (with panic hardware), and protective walk covers. For more information relevant to aluminum products for school construction write for File SS-65, Kawneer Company, Inc., 1105 N. Front St., Niles, Michigan 49120. ◀◀

glass conditioning in modern schools

Pittsburgh Plate Glass Company

Modern schools dotting the countryside stand as a symbol of growth and development of new ideas, new techniques, in which *design* and *construction* play a vital role in the educational environment of the youth of our nation.

These single and multi-storied buildings represent a complex structure of many kinds of classrooms in our educational process. Today, newer concepts of education enhance the teaching and learning process of the individual in a stimulating atmosphere designed to help each student fulfill his potential.

In our educational process, which is in a rapidly-advancing period of transition, new architectural forms have emerged from new educational functions. Industry, through research, is providing building materials and techniques for architects to create new combinations of structure that will combine both economy and efficiency with low maintenance in response to the demands of school administrators faced with the rising costs of education.

Technological advancements in building materials—among them, glass, with its functional benefits in contemporary school design—have brought about new uses for this versatile building product.

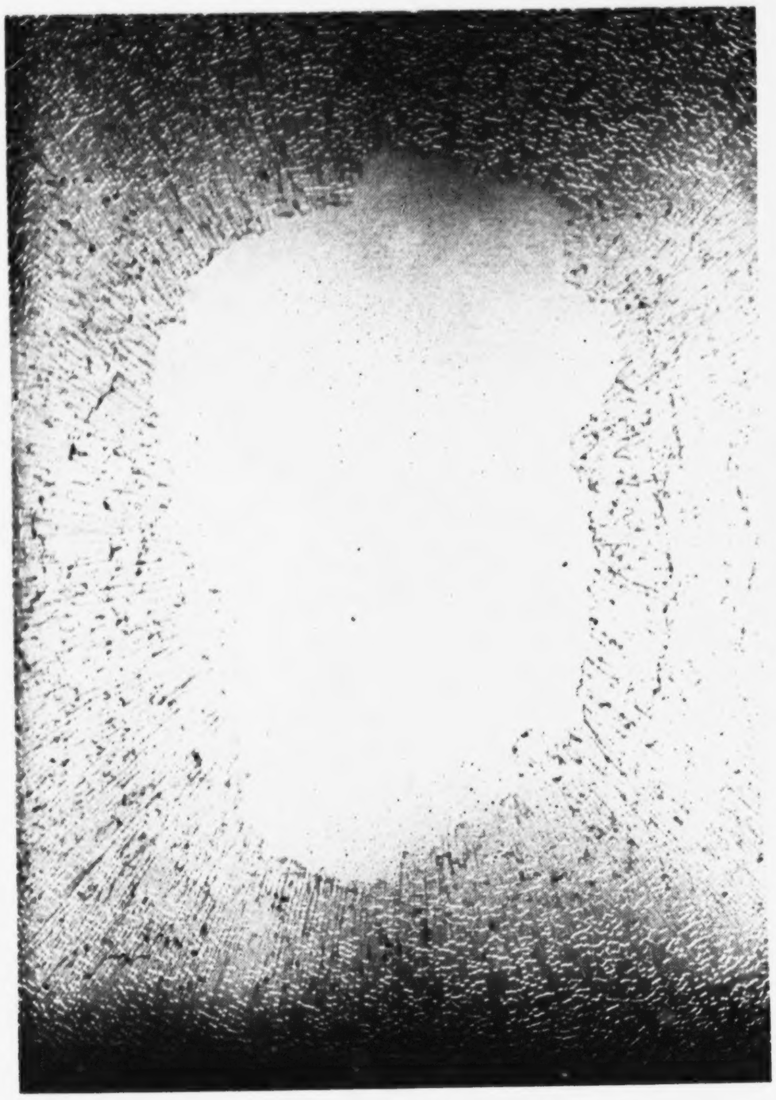
At Pittsburgh Plate Glass Company, research scientists have developed an idea—*glass conditioning*—into tangible reality in the modern school, to help school administrators give every person thirsting for education the best possible learning environment in this pursuit.

What is *glass conditioning?* (A PPG Service Mark.)

It's a new concept for improving learning environment, through selective use of glass, scientifically designed to provide physical comfort and psychological satisfaction and economies in:

Environment—Students and teachers feel happier and work better in an environment for teaching and learn-

PPG GRAYLITE helps provide a stimulating atmosphere, encourages students to use their library. There are PPG environmental glasses to promote indoor comfort for any building, regardless of location, environment and exposure.



Break pattern of HERCULITE

Break pattern of conventional glass

ing that is stimulating, bright, and cheerful—which PPG environmental control glasses provide in classrooms, corridors, libraries, labs, and gymnasiums.

Structure—Glass, as a cost-saving building material, provides: (1) lighter weight; (2) maximum use of floor space; (3) less costly structural support; (4) greater heating and air-conditioning savings; (5) lower maintenance.

There is maximum safety protection with HERCULITE tempered safety glass, where doors, entrance-ways, partitions, etc., are subjected to other than ordinary impact conditions. This glass has eight times the impact resistance of regular glass and does not splinter into sharp, jagged edges. It crumbles into small rounded fragments.

Flexibility—Selectivity of environmental glasses control light, heat, glare, sound, and various combinations of these elements, regardless of climate or building orientation. Specially developed green, gray, or bronze glasses used in double-glazed insulating unit: (1) reduce heat loss; (2) cut heating costs; (3) lower air-cooling expense.

Interior glass partitions permit efficient transfer of natural and electrical lighting, minimize the problem of supervision, and provide privacy without creating a gloomy closed-in atmosphere.

Maintenance—HERCULITE tempered safety glass reduces glass replacement from breakage. NUCITE heat-strengthened plate glass chalkboards are virtually maintenance-free with permanently fused vitreous enamel surface. Installation cost no more than boards of less durable material. SPANDRELITE colored glass panels in curtain wall require no resurfacing, painting, or special cleaning.

Significantly, in educational construction, each side of a school building presents a different indoor environmental control condition, requiring a different glass to establish and maintain optimum conditions for visual and psychological comfort and efficiency.

PPG's Glass Conditioning offers architects and educators a broad range of solar and insulating glasses, and light and heat reflecting glass products. Each varies in performance characteristics and cost to meet widely differing conditions as heat loss or gain, glare reduction and heat absorption, light and heat reflection.

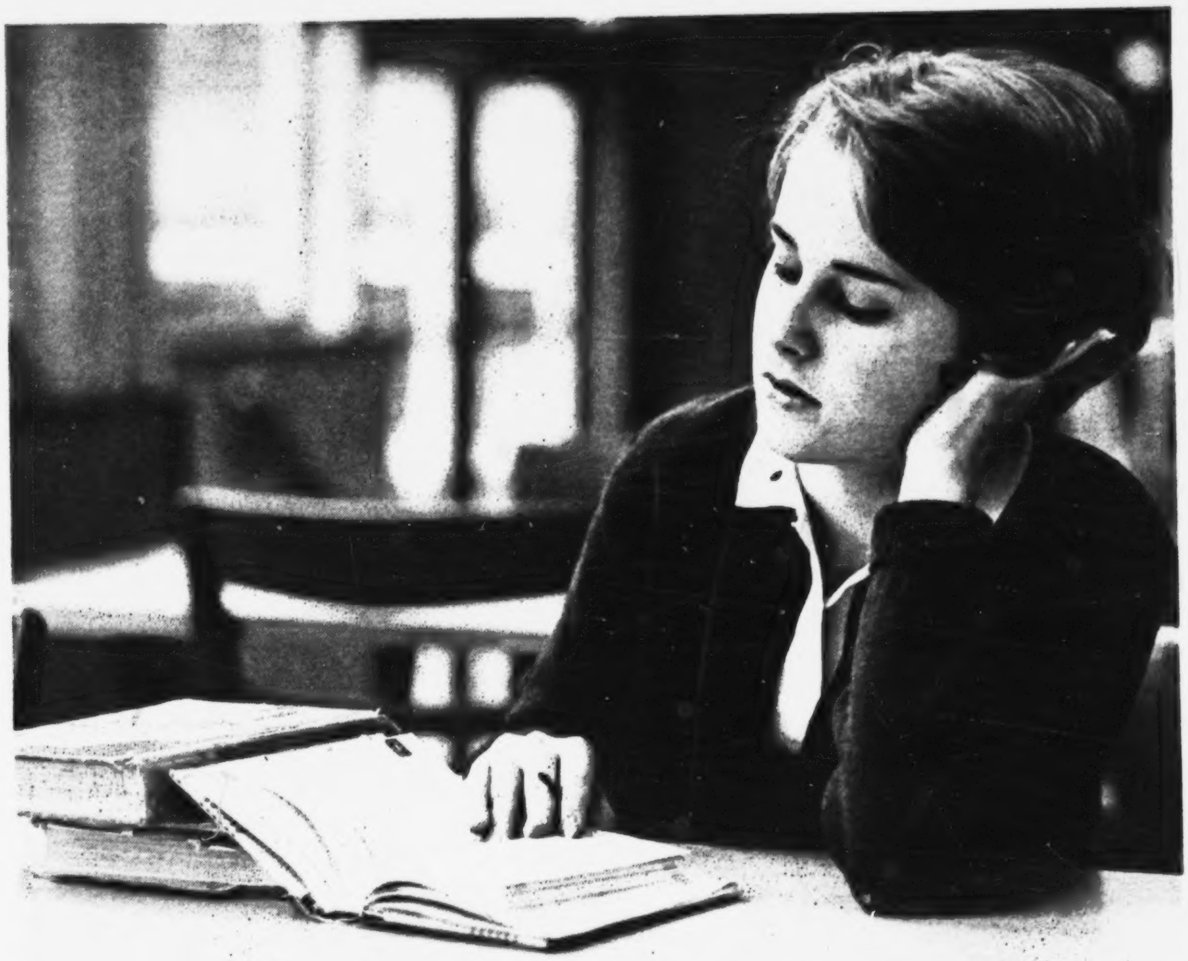
PPG's complete line of environmental control glasses (see chart), scientifically designed to produce the highest possible efficiency in school building operating costs, include such multi-functional products as:

GRAYLITE:

- Combines economical brightness control as exposure and other site conditions require with high optical standards of the finest window glass.
- Costs very little more than conventional window glass.
- Five different densities provide range of daylight transmittance from 14% to 61%.

SOLARGRAY:

- Combines heat-reducing properties with the reduction of visible light transmittance to provide both heat



Controlled daylight contributes to a healthy learning environment. Yet GRAYLITE adds as little as $60 to the cost of average schoolroom.

and glare control without color distortion.

SOLARBRONZE:

- Warm gray-bronze hue whose light transmittance is slightly higher than that of SOLARGRAY.
- Heat-reducing properties are similar to SOLARGRAY.

TWINDOW INSULATING GLASS:

- Cuts conducted heat loss to half that of window glass.
- Unit with two panes of clear plate glass with hermetically sealed insulating space between reduces heat loss in winter, lowering heating costs.
- Combination unit with pane of SOLEX, SOLARGRAY or SOLARBRONZE, offer radiant heat and brightness control. Also available with pane of GRAYLITE window glass.

SOLARBAN TWINDOW:

- Provides ultimate in indoor comfort.
- Transmits only one-third as much heat as regular ¼-inch plate glass.
- Cuts heat loss or heat gain 66%.
- Transmits only about 20% of sun's visible rays, greatly reducing glare.
- Substantial savings in heating and air conditioning.

For appearance, safety and practicality in your school building and modernization program, contact your nearest PPG branch or distributor, or write Pittsburgh Plate Glass Company, One Gateway Center, Pittsburgh, Pennsylvania 15222, for any assistance or technical data on glass conditioning you need. ◀◀

COMPARATIVE PERFORMANCE DATA

		U Value	*Maximum Heat Gain (BTU/hr./sq. ft.)*	*Visible Light Transmittance %*
Plate Glass				
Regular Plate Glass	¼″	1.1	200	88
Solargray®	¼″	1.1	150	42
Solarbronze®	¼″	1.1	150	51
Solex®	¼″	1.1	150	73
Sheet Glass				
Clear Sheet Glass	3/32″	1.1	205	90
Graylite™ 31	⅛″	1.1	170	31
Graylite 61	3/16″	1.1	195	61
Graylite 56	7/32″	1.1	190	56
Graylite 14	7/32″	1.1	150	14
Graylite 52	¼″	1.1	185	52
High Performance (Insulating, Heat and Glare Reducing)				
Clear Twindow®		.60	170	78
Solarban Twindow		.35	65	20
LHR Solargray Twindow		.60	90	22
LHR Solarbronze Twindow		.60	90	25
LHR Solex Twindow		.60	90	32
Solargray Twindow		.60	115	36
Solarbronze Twindow		.60	115	45
Solex Twindow		.60	115	65

metal doors/frames in modern schools

The Steelcraft Manufacturing Company

Schools today must meet exacting design criteria for structural qualities, flexibility of use, proper environment and efficient maintenance.

The doors in a school probably receive more hard wear and abuse than any other part of the structure. For instance, it has been estimated the entrance doors on a school are used approximately 225,000 times a year. Metal doors and frames, with their superior characteristics of strength and stability, are better able to take (and resist) more bumping, banging, slamming, use and abuse than any other kind of door and frame. In addition, weather and atmospheric conditions do not affect the operation of metal doors.

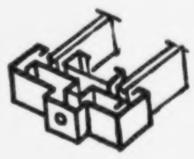
Fast delivery is also essential if today's construction schedules are to be met. The Steelcraft Manufacturing Company has been able to combine quality with ready availability by a heavy investment in research and development, independent product testing, quality control and production tools, machinery and techniques. The result: standard metal doors and frames designed and produced to meet rigid architectural and construction standards.

A nationwide network of local distributors inventory Steelcraft metal doors and frames for quick delivery. The local Steelcraft distributor is technically trained to act as an advisor on door and frame selection and specifications. These distributors are also factory trained and locally equipped to modify Steelcraft doors when required for the addition of lites, louvers, grilles and hardware. They are prepared to weld door frames or fabricate window walls, entrance ways, side-lites, borrowed lites or transoms from door frame components —called "sticks."

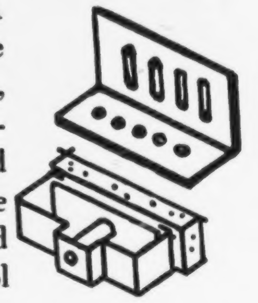
Data shown is only a small part of the important information relative to school construction. But answers to specific questions and further information can be obtained by contacting the Steelcraft distributor in your area or by writing to: The Steelcraft Manufacturing Company, 9017 Blue Ash Road, Cincinnati, Ohio 45242.

Characteristics

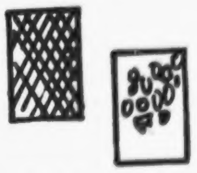
Tough and Rugged—Tests and usage have proven that honeycomb reinforced doors are stronger than intermittently metal stiffened doors. Resistance to impact is exceptionally high.



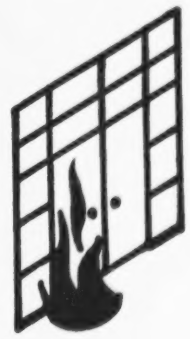
Versatile—Steelcraft standard frames are used to butt or wrap around masonry construction. Wood and steel stud or solid plaster partitions also use standard steel frames; frames for drywall construction are excellent for use with sound control partitions and can be reused in demountable partitions. Steelcraft's "drywall" frame goes up after wall is erected!



Flexible—There is complete freedom and choice of hardware as a result of standard hardware preparations. Doors can be prepared for practically all builders hardware. All frames are prepared for ASA strikes. Frames with adjustible base anchors, for installation on sub floors, allow freedom of choice in the selection of finished floor thicknesses and materials. Anchors for existing walls are available for easy installation of standard frames in remodeling school and school addition programs.



Wide Selection of Finishes is Available—textured steel for decorative effect and strength; stainless for corrosion protection in swimming pool and kitchen openings; galvanized steel for exterior openings; grain finish for warm interiors. Steelcraft doors and frames are bonderized and prime painted at the factory to protect the steel unit; it is finish painted in the field. Of course, a finish paint to match any color chip can be applied at the factory.



Safety—Steelcraft labeled fire doors and frames provide the maximum protection from fire and smoke. Steelcraft's many fire rated products have been successfully tested with the latest fire and panic hardware. Smoke screens up to 10′0 wide by 11′0 high can be furnished with ¾-hour rating for corridor dividers and stairwell enclosures.

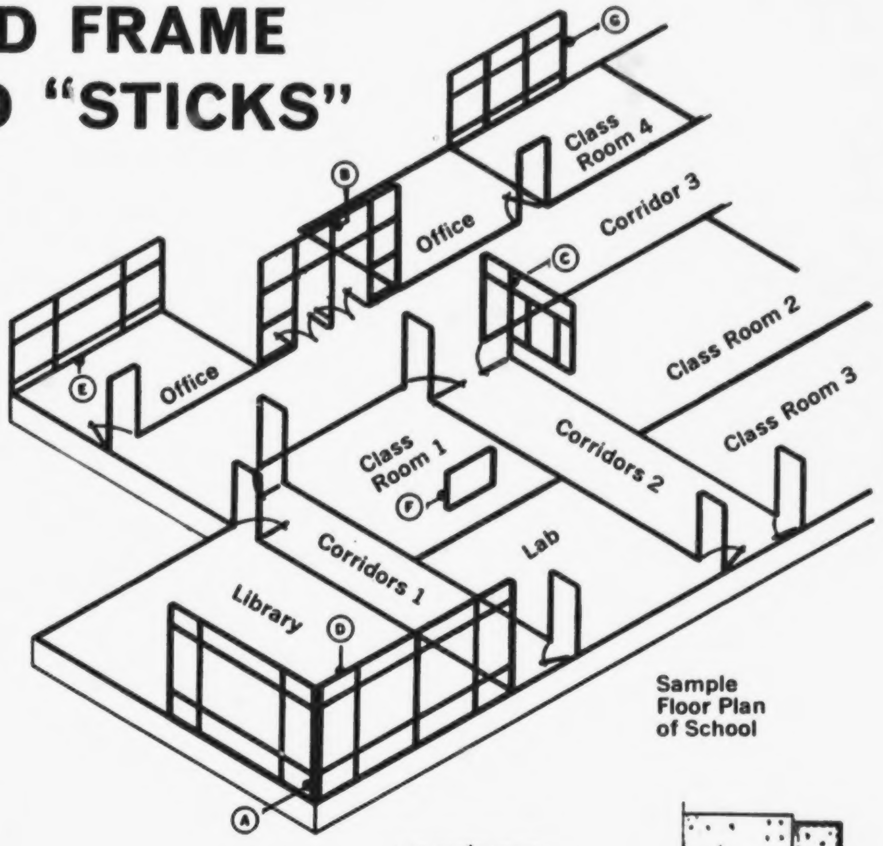
Note: Also see "Door Selection Guide" on page 36.

TRANSOM AND SIDELITE FRAMES FROM PRE-ENGINEERED FRAME COMPONENTS CALLED "STICKS"

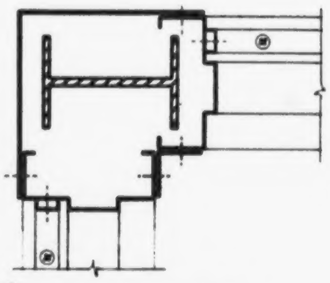
Literally thousands of design variations in made-to-order transoms, sidelites and borrowed lites can be quickly fabricated from local stocks.

Steelcraft "sticks" are available in double rabbet jamb depths of 4¾", 5¾", 6¾", 8¾", and single rabbet jamb depths of 3" & 3¾", for 1¾" doors. Transom & sidelite frames can be fabricated from these sections to fit any wall condition.

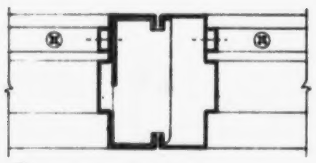
All frames are available in both 16 & 14 gage steel. 14 gage frames are sometimes required to withstand severe abuse or for extremely high frequency openings.



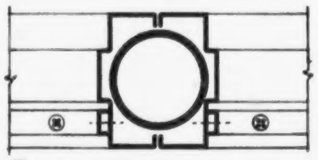
Sample Floor Plan of School



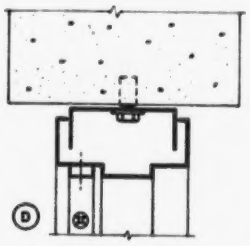
Ⓐ Corner Connection



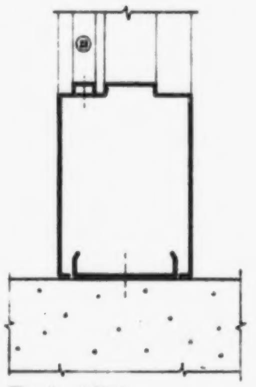
Ⓑ Vertical Mullion Using Splice Anchors



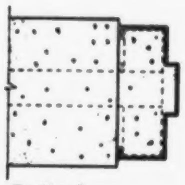
Ⓒ Column Condition



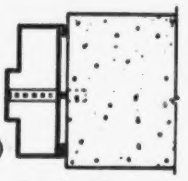
Ⓓ Adjustable Connection at Precast Concrete Lintel



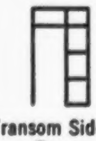
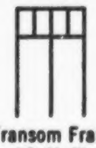
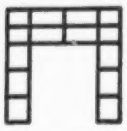
Ⓔ Typical Sill

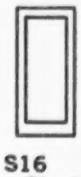


Ⓕ Butted Masonry



Ⓖ Anchor for Existing Wall

<table>
<tr><th colspan="7">UNDERWRITERS' LABEL DOORS & FRAMES</th></tr>
<tr><th colspan="6">Doors</th><th>Frames</th></tr>
<tr><td>Label Classification And Use In Buildings</td><td>A—3 hour rating, openings in fire walls and division walls between buildings with a rating of 3 hours.</td><td>B—1½ hour rating, openings in vertical shafts with a rating of 1½ hours.</td><td>C—¾ hour rating, openings in corridors and room partitions with a rating of ¾ hours.</td><td>D—1½ hour rating, openings in exterior walls with a rating of 1½ hours.</td><td>E—¾ hour rating, openings to exterior fire escapes with a rating of ¾ hours.</td><td rowspan="3">THREE SIDED FRAMES
Standard label frames are not rated and may be used for any label classification door.
Anchors approved for all common wall conditions.
TRANSOM & SIDELITE FRAMES

Transom Sidelite Frame ¾ hr. rating

Transom Frame with Mullion ¾ or 1½ hr. rating

Transom Sidelite Frame ¾ hr. rating

Transom Frame ¾ hr. rating</td></tr>
<tr><td>Maximum Glass Area</td><td>No Glass is Permitted</td><td>100 sq. in. per opening, single doors—10" x 10" standard.
Pair of doors standard opening 7" x 7" per leaf.</td><td>1296 square inches per lite. Neither dimension may exceed 54".</td><td>No Glass is Permitted</td><td>720 square inches per lite. Neither dimension may exceed 54".</td></tr>
<tr><td>Door Lines Available</td><td> Flush
H18 & L16 1¾"
Single 4072
Pair 8072
L20 & L18 1¾"
Single 3872
L20 1⅜"
Single 3472</td><td>Flush
H18 & L16 1¾"
Single 4072
Pair 8072
L20 & L18 1¾"
Single 3872
Pair 7472
L20 1⅜"
Single 3472</td><td colspan="3">Stile & Panel
S20 1⅜"
Single 3072
S20 & S18 1¾"
Single 3072
Pair 6070
 Stile & Rail
S16 1¾"
Single 4080
Pair 8080
Flush & Recessed Panel</td></tr>
<tr><td></td><td colspan="5">No. In Door Designation Indicates Gage of Steel.Example:L20 is 20 Ga. Steel.
NOTE: L20 DOORS AVAILABLE IN PATTERN STEEL EP1 & EP2.</td><td></td></tr>
</table>

DOOR SELECTION GUIDE RECOMMENDED FOR SCHOOLS

Door Location	Door Thickness	Door Type						Door Design						Material					Misc.		
								Stile & Panel		Full Flush			Stile & Rail	Cold Rolled Steel	Galvanized Steel	Aluminum	Stainless Steel	Pattern Steel	UL. Classification	Louver	Frame Gage
		'M'	'G'	'V'	'NL'	'LG'	'LG3'	20 ga.	18 ga.	20 ga.	18 ga.	16 ga.	16 ga.								
Boiler Room	1¾″	●							●		●	●	●	●					A		16
Cafeteria to Kitchen	1¾″			●	●			●		●	●						●				16
Coat Rooms	1¾″	●						●		●				●				●			16
Conference Room	1¾″	●	●	●							●	●		●		●		●			16
Corridor to Auditorium	1¾″	●		●	●					●	●	●		●				●			16
Corridor to Labs	1¾″	●	●	●	●				●		●						●				16
Corridor to Office	1¾″	●	●	●	●				●		●			●		●		●		●	16
Corridor to Toilets	1¾″	●							●		●			●						●	16
Corridor to Vestibule	1¾″		●		●	●	●				●	●	●	●				●			14
Elementary Class Rooms	1¾″		●	●	●				●	●	●			●				●			16
Entrance to Vestibule	1¾″	●			●	●	●				●	●	●	●	●						14
Gymnasium to Exterior	1¾″	●	●						●		●	●	●		●						14
Janitors' Closets	1⅜″	●						●		●				●							18
Kitchen Screen Doors	1⅜″					●		●						●	●						16
Locker Rooms & Pool Room	1¾″	●								●	●				●		●			●	16
Music Rooms	1¾″	●	●	●	●				●	●	●			●				●			16
Nurses' Room	1¾″	●							●		●						●				16
Passage to Library	1¾″	●	●	●	●	●	●			●	●	●		●				●			16
Passage to Gymnasium	1¾″	●									●	●	●		●		●			●	16
Passageway	1¾″	●	●			●	●					●	●	●					C		16
Primary Toilets	1⅜″	●						●		●				●						●	18
Principal Office	1¾″	●		●						●	●			●				●		●	16
Receiving Rooms	1¾″	●									●			●		●					16
Stairhall	1¾″				●	●	●				●	●	●	●					B		16
Store Rooms	1¾″	●						●	●	●	●		●	●					B		16
Supply Rooms	1¾″	●							●		●	●		●					B		16
Teacher Closets	1⅜″	●						●		●				●							18
Teachers' Lounge	1¾″	●								●	●			●		●				●	16
Transformer Room	1¾″	●						●	●	●	●			●	●				A		16
Utility Room (Exterior)	1¾″	●						●	●	●	●				●						16

Notice

1. The doors recommended in this chart were determined by: (A) frequency of use; (B) type of doorway use; (C) desired appearance; (D) cost.
2. Caution—Local code requirements should be checked before making selections from this chart.

NOTE

FOR MORE DETAILED INFORMATION WRITE FOR STEELCRAFT'S ARCHITECT MANUAL.

STEELCRAFT
THE STEELCRAFT MANUFACTURING COMPANY
In U.S.A. . . Cincinnati, Ohio 45242
In Canada . . Malton (Toronto), Ontario

finest name in metal doors and frames

space grid system for school design

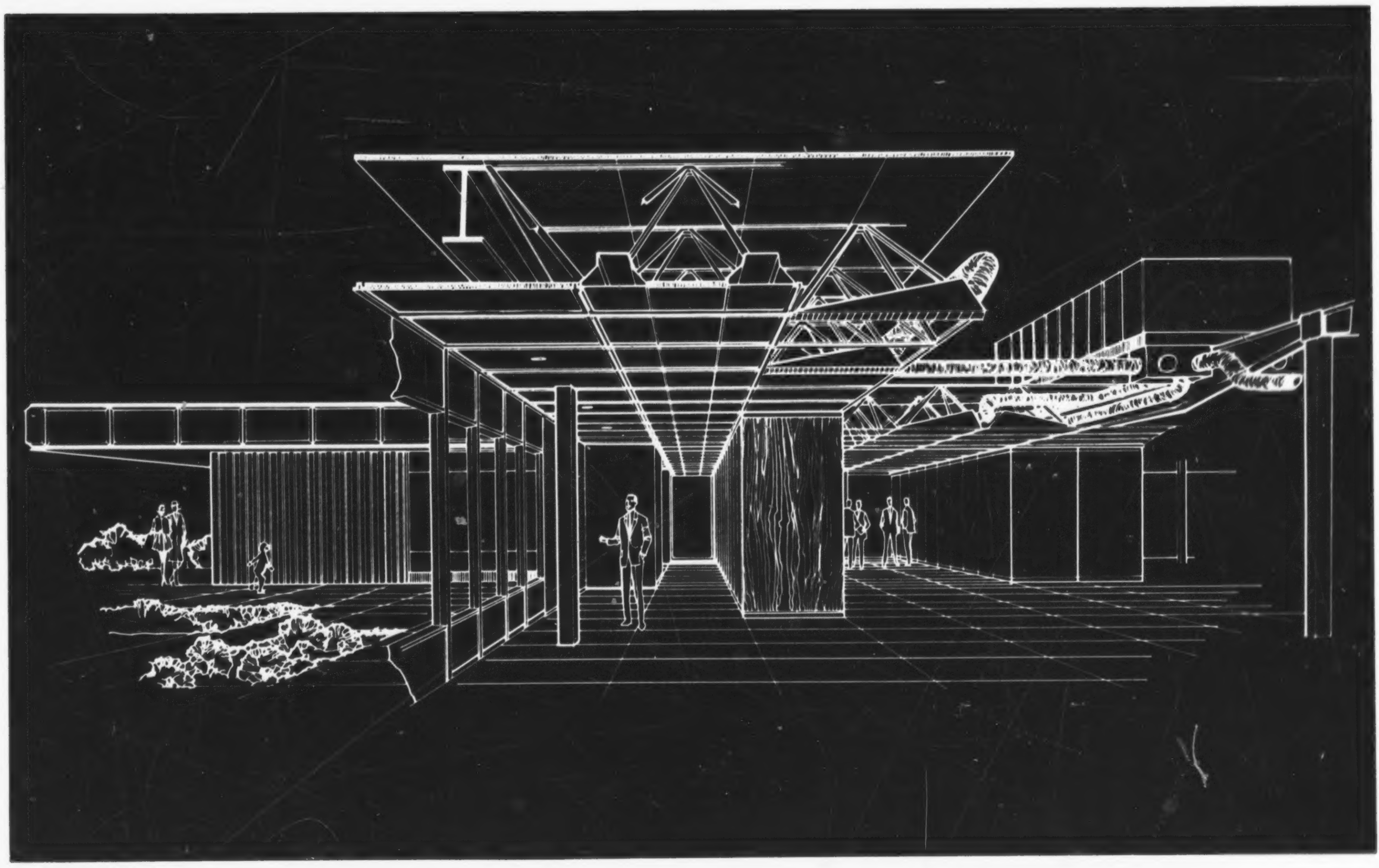
Butler Manufacturing Company

Educators' facility requirements today are predicated on a variety of possibilities of space/environment rearrangement, as well as on anticipation of future requirements which may not resemble those in use today. This makes coordinated space/environment flexibility a basic design criteria. Space Grid* achieves this flexibility to a high degree.

Space Grid is a comprehensive component system (patent pending) of construction in which space can be substantially altered while retaining standards and control of environment. Structural variations permit the construction of any size building in five-foot modules in any direction. This multi-functioning structural universe provides both load bearing capability and a service envelope above the ceiling plane. With compatible lighting/ceiling, heating/air conditioning components and other utilities overhead, room dimensions can be changed with movable and operable partitions without affecting the rest of the environment. The structural system itself is neutral in its influence on design, encouraging a wide range of architectural solutions to accommodate the creative designer.

Design for Environment

The Butler Space Grid system provides a unique method of developing the environmental requirements for modern educational planning. In this system, the component modifiers of environment—heating/air condition-



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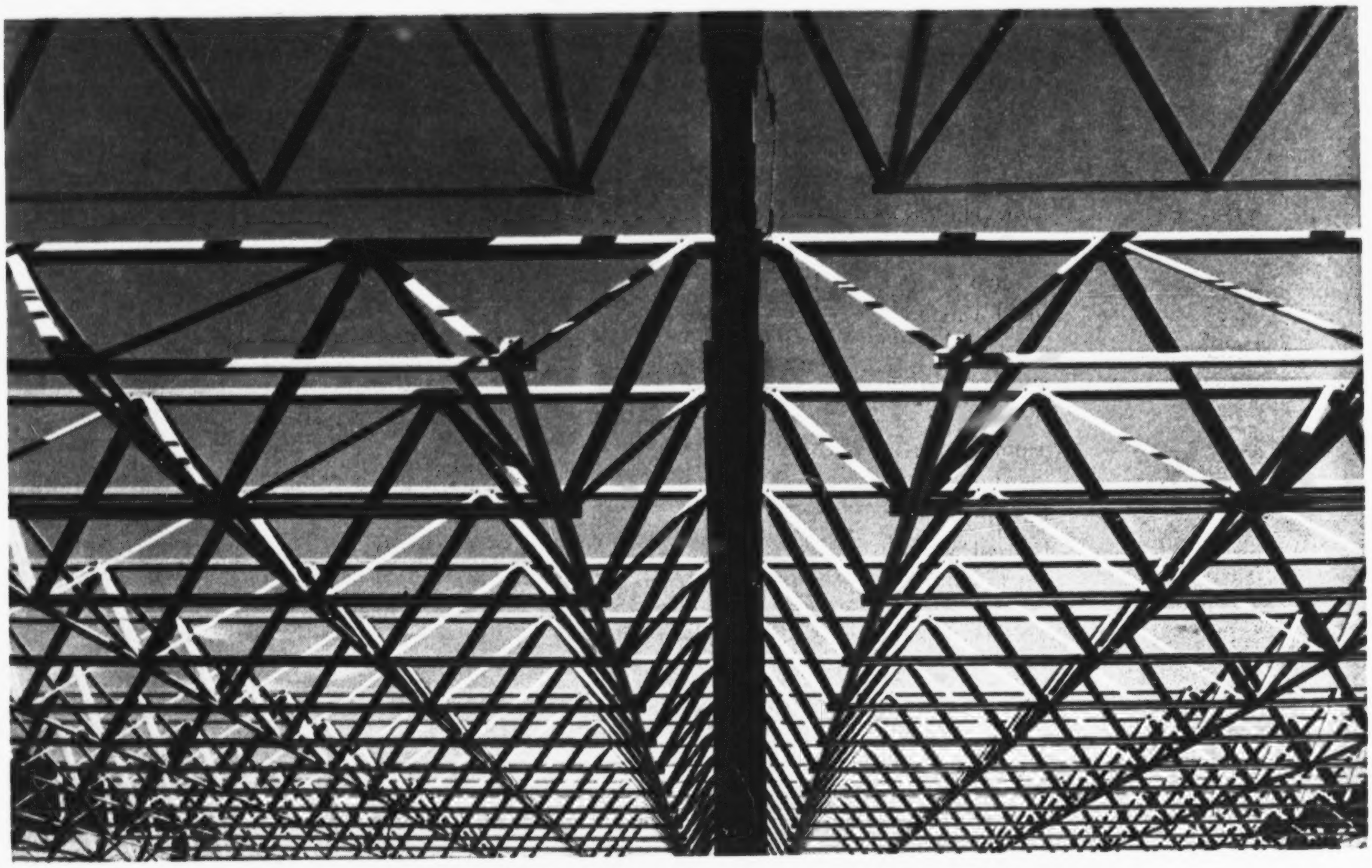
*Registered trademark of Butler Manufacturing Company, Kansas City, Missouri. Patent rights pending on design of Space Grid components.



STRUCTURAL SYSTEM—A series of Space Trusses, assembled in parallel, form the secondary structural system in place. The primary structural support is a system of roof beams and slender columns. The system is easily expandable to the horizon on all sides, in endless multiples of basic bay dimensions.

ing and lighting/ceiling—are design-integrated in a service envelope which serves as a universal control center.

The service envelope is the area between the roof and ceiling planes. With the service envelope thus located, the architect and the educator have complete freedom to apportion space and to control heat, air conditioning, light and sound.

Design for Flexibility

Space Grid establishes two structural constants, the plane of the slab and the plane of the structural service envelope. Between these constants, everything—lighting/ceiling components, ducts and utilities, heating/cooling equipment, partitions, closures—is relocatable and easily capable of change.

Complete flexibility with economy in this system means that space and environment are completely fluid. You can change space and maintain environmental control.

Design for a Better Structure

The structural component of Space Grid offers more than a primary structural support for enclosure. The steel Space Trusses form a 35-inch deep service envelope which performs many functions. For example, the five-foot grid expressed by the base members provides a uniform ceiling plane, as well as support for ceiling, lighting and partitions.

The one-inch space between base members is a breathing space for supply and return air. The service envelope encloses the distributors of environment—lighting/ceiling and heating/air conditioning—and provides an organized network for the passage of other utilities.

Buildings may be planned or extended in five-foot increments in any direction at any time. Structural planning and space freedom are maintained by the fixed base tubular columns which are independently stable, requiring no X-bracing or shear walls. This neutral, multi-functioning system allows the architect complete control in executing his design prerogatives.

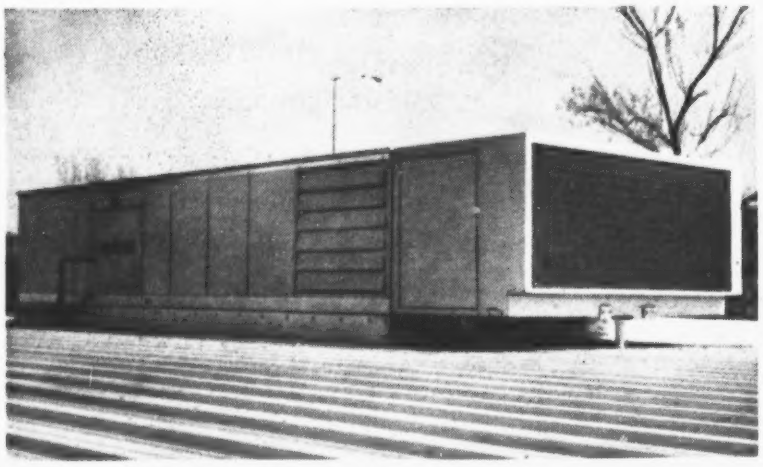
Design for Maintenance

In Space Grid, the concept of component integration (inter-action) offers the architect a basis for minimizing total ultimate educational costs. For example, the Space Truss service envelope provides access to lighting/ceiling, ducts and utilities for repair and maintenance. Heating/air conditioning is readily accessible. Integral partitions may be moved or taken down for maintenance.

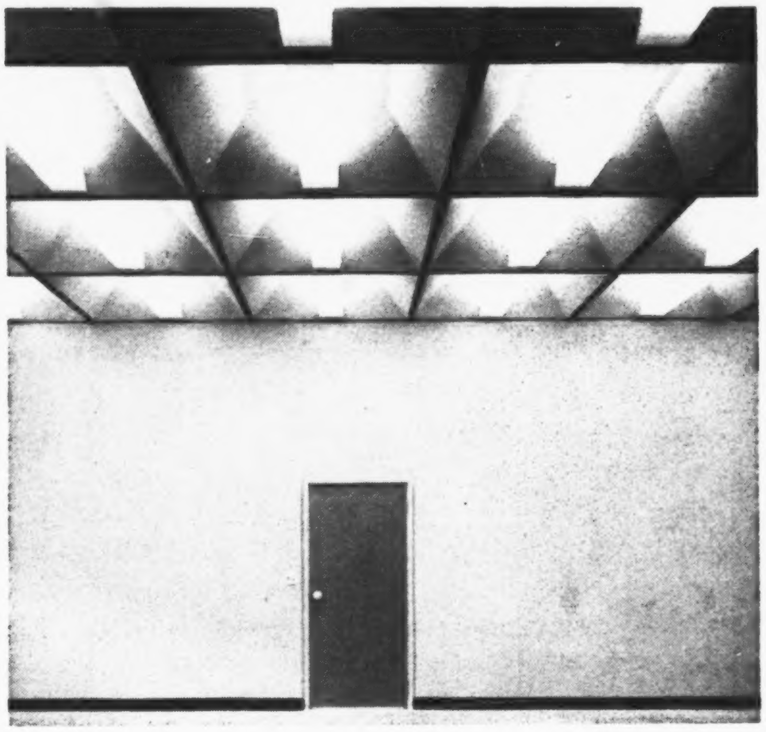
Some roof and wall systems integral with Space Grid offer thermal efficiencies and surface finishes which substantially reduce operating and maintenance costs.

The architect has freedom to select and design components based on an analysis of performance equated against first and ultimate costs. ◀◀

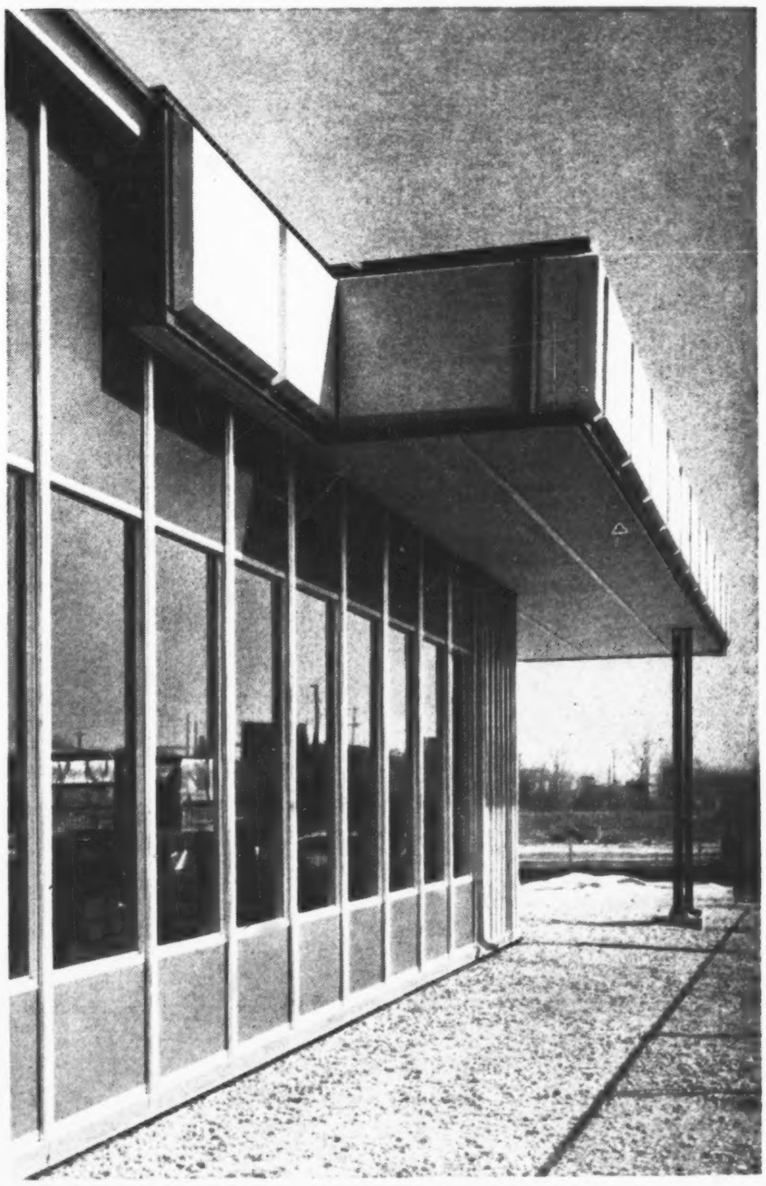
ROOF & FACIA—Precision-fabricated, insulated metal roof systems or built-up roofs of high performance characteristics are available with Space Grid, along with deep facia panels or two-tone facia trim.



MECHANICAL EQUIPMENT—Heating/air conditioning is based on the concept of the mechanical service module (individual units for 3600 to 5500 square feet). Roof-mounted heating/cooling equipment can serve as many as 12 different temperature zones, each independently controlled by its own thermostat.



LIGHTING/CEILING/INTERIOR WALLS—Easily installed, compatible systems come in a full selection of designs to meet different needs. Lighting can be direct or semi-direct. Ceilings may be flat or shaped in a variety of decorative, acoustical materials. Movable or operable walls of modern appearance and durability create areas of variable space, quiet elegance.



EXTERIOR CLOSURES—Space Grid allows complete freedom in the selection of closure materials. The architect may choose from traditional materials, precision-fabricated, insulated curtain wall systems or combinations of both.

schools and the flexibility factor

The E. F. Hauserman Company

It is the difficult and critical task of the school administrator to bring together those who teach and those who are taught in the most effective possible manner. The job is complicated by the factor of constant change: in emphasis on areas of knowledge, in size of enrollment, in techniques and apparatus of teaching, in demands placed on both those who teach and those who are taught.

Obviously the administrator cannot do this job if his ability to plan, innovate, and schedule is restricted by the physical limitations of the school building. Unless a school is designed to accommodate change, in whatever form it takes, it is destined for obsolescence. At the very same time that space cannot be found in such a school to house an essential educational activity, large areas in the building may actually be idle because the purpose for which they were created has changed. The administrator, however, working with a skillful architect, who employs the modern technology developed by imaginative suppliers of building materials, can plan schools which will meet today's needs and anticipate tomorrow's. Such buildings are not only better schools but, because they permit maximum utilization of expensive space, they are more economical.

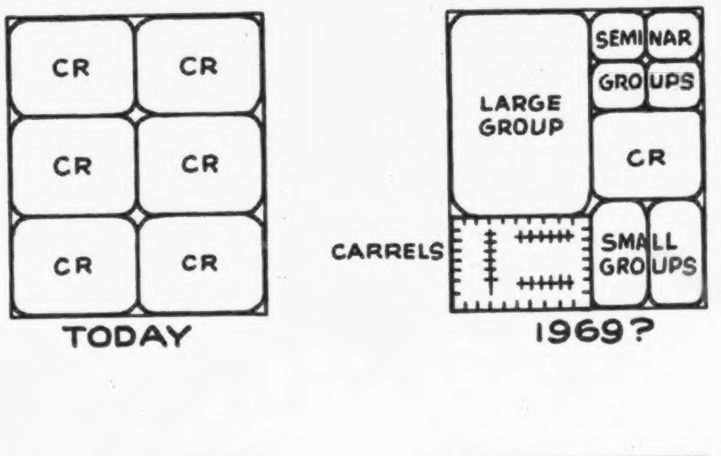


Figure 1—An English Department in School "X."

The accompanying diagram (Fig. 1) shows a room layout which accommodates the curriculum and teaching techniques of an English Department in School "X." Educators tell us that the space allocation of today may be inappropriate for the curriculum content and teaching methods of 1969, 1972, and so forth for the life of school building "X."

The cost of demolishing and replacing permanent walls to accommodate needed changes would be exhorbitant and time consuming. As a result, the educator is at the mercy of the budget and progressive changes in educational techniques are inhibited.

The E. F. Hauserman Company is successfully working with leading architects to find a solution to the "flexibility problem" which faces today's schools. The products newly developed for this purpose are: (1) Hauserman Co-ordinator Double-Wall, and (2) Hauserman Operable Wall.

Both these products afford the flexibility educators say they need today, and provide it in two different and distinct manners.

Hauserman Double-Wall

Hauserman Double-Wall is a *low-cost* metal demountable wall. It offers all the advantages of a permanent wall, plus the ability to be taken down and completely re-erected in a new location. These newly formed teaching spaces help to eliminate the frustration of tomorrow's "curriculum/space" problem which will occur in School "X." Changes can be made over a week-end, between semesters or every two or ten years—as required—

Hauserman Double-Wall (right) in the classroom.

quickly and *economically.* This is the function of Hauserman Double-Wall!

Double-Wall was designed to meet the exacting specifications set up by a group of educators, school construction specialists and architects interested in school design. The project, known as School Components System Development, operating under the sponsorship of the Educational Facilities Laboratory of the Ford Foundation, was set up to encourage the development of building components that could contribute to total flexibility in schools.

Hauserman Double-Wall was selected by this group for use in 22 schools in 13 California districts. This wall system, with the same advantages, is now being used in schools throughout the country.

Flexibility at Low Cost

Double-Wall is the answer to every school's need for low-cost space flexibility. It provides for the adaptation of classrooms to make possible the use of new teaching tools; for alteration of layouts in a single area or throughout a school, quickly, easily, economically. Double-Wall is an attractive, durable, impact-resistant wall system, trim, modern and completely flush in appearance. Panels are delivered prime-coated and are finished in an unlimited choice of colors after installation. Surfaces may be covered in a wide variety of wall covering materials and the perfectly flat panels and tight joints make possible the use of chalk and tackboard. This rugged, sturdy wall supports shelves and wall-hung equipment—up to 750 pounds per panel.

Double-Wall becomes a functioning part of the environment, adapts quickly and easily to changing requirements. To meet the needs of changing enrollment or in the way space inside the school is used, Double-Wall is completely demountable with almost one hundred percent re-useability of components.

The double panel construction of Double-Wall, the tight sure fit of panel to post, complete perimeter seals at floors and at ceilings and end walls, makes the system an effective sound barrier. It has a Sound Transmission Class (ASTM-E90-61T) of 43. All components are completely incombustible and the system can be easily adapted to achieve a full one-hour rating where required.

Double-Wall is rigid and sturdy in construction (See Fig. 2). Panels consist of two sheets of steel laminated to both sides of a gypsum core. Each side of the Double-Wall post receives two panels spaced 2 3/16" apart, forming a true Double-Wall. These panels snap easily into place, are held securely from floor to ceiling. Plenty of room is provided for electricals and utility service between panel faces and through the posts. When a change is required—to add or alter wiring for a new visual device, for instance—access is quick and easy. When the alteration is made, panels snap back into place with no need for patching, painting, or repairing the surface.

With this new, low-cost wall, we have, in effect, entered the school insurance field. However, there is no annual premium and you collect your benefits immediately. The school building is assured against *cracked walls, sound leaks,* and *high maintenance costs.* Best of all, the school is assured against interior-space-change

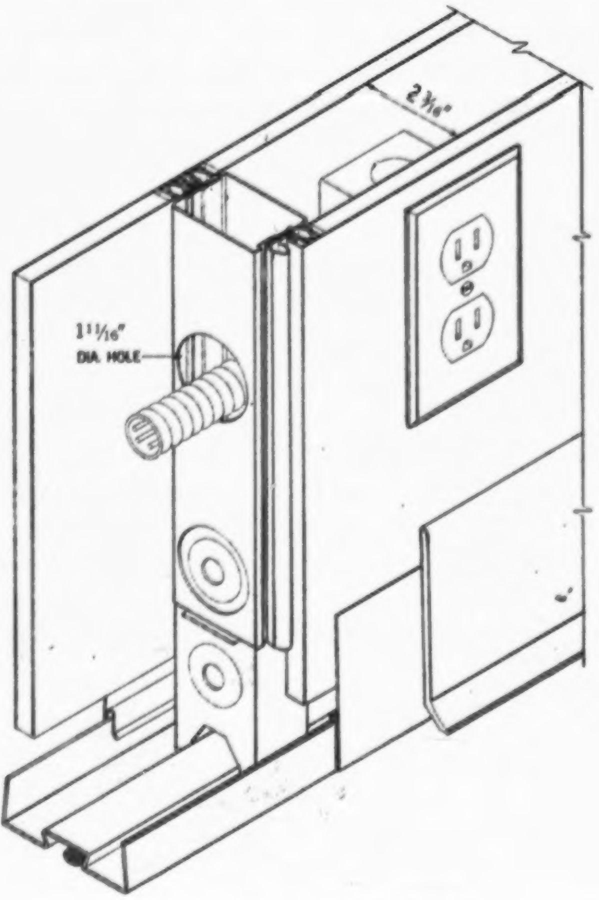


Figure 2—Isometric of Double-Wall.

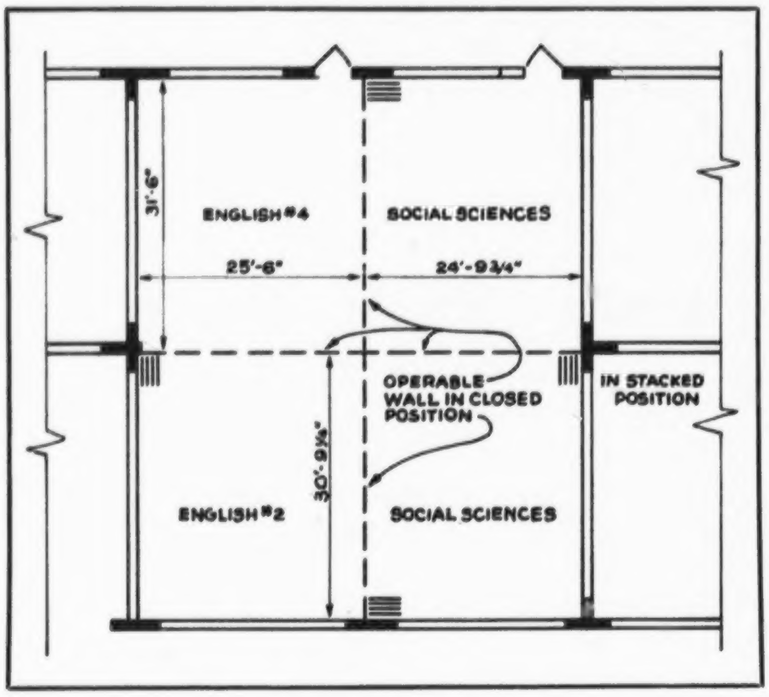


Figure 3—Operable Wall in action.

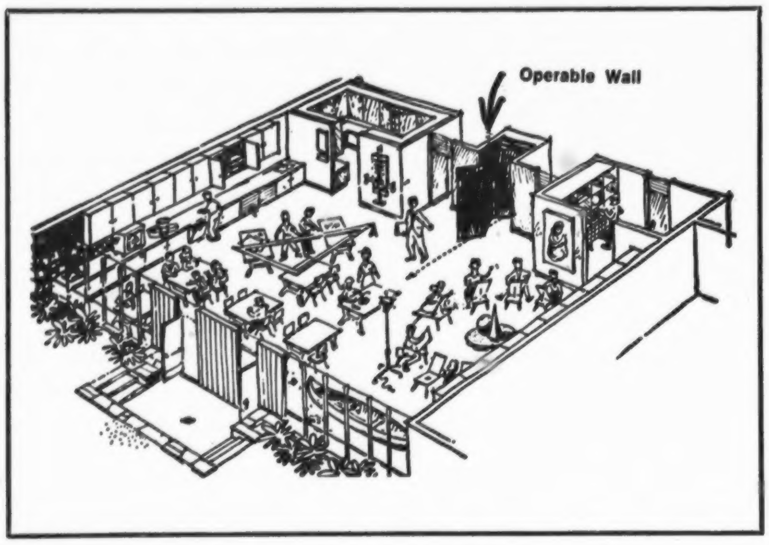


Figure 4—Operable Wall and instant flexibility.

Operable Wall in the school.

obsolescence. Thus, with Double-Wall, long-range flexibility is attained.

Hauserman Operable Wall

Hauserman Operable Wall provides the second type of flexibility. It is a sliding acoustic barrier which moves easily in or out of place, on an overhead track, to provide the instant flexibility needed in today's classrooms—day-to-day flexibility. Some of the benefits derived from this wall are shown with these examples.

The accompanying diagram (Fig. 3) shows a school in Maryland. Operable Wall is used to separate the two halves of an English class and the two halves of a Social Studies class with a third and fourth Operable Wall in between. The four rooms can be opened up into one large room, 50′ x 62′, should the need arise for a large group instruction.

Figure 4 shows an elementary school in Connecticut, using Operable Wall between two rooms, each 750 square feet. With Operable Wall in place, the two rooms are used for small group instruction; in stacked position, the room is opened up for large group instruction. Large space, small space, either are created instantly.

To vary space to the need of any hour of the day, Hauserman Operable Wall glides smoothly, silently, easily, in and out of place at a teacher's touch. In place, it is in fact a wall—a sound-stopping, solid, rigid structure that provides for all of the work surfaces needed such as chalk and tackboard.

The superior performance of Operable Wall as a sound barrier is the result of its panel construction. Individually hung steel panels, packed with rockwool, join each other tightly and are double-sealed by interlocking gaskets at all joints and at the perimeter. Hauserman Operable Wall delivers sound control equal to that of fixed walls used to divide classrooms. Technically, Operable Wall, tested under ASTM-E90-61T, has a Sound Transmission Class of 43. In numerous actual installations throughout the country, Operable Wall has proved to be most effective in producing required privacy.

Installed by Hauserman specialists, this trim, modern wall has no complicated mechanism to break down, and with its lifetime baked-enamel finish, reduces maintenance costs to a minimum. The Hauserman Operable Wall is an ideal way to provide *instant* flexibility for your schools.

Summary

With Hauserman Double-Wall to provide the low-cost, long-range semester flexibility for the life of the school building and Operable Wall to provide the day-to-day instant flexibility, maximum utilization of space is made possible. Both products are compatible and can be installed separately or together in a school to provide *total* flexibility for the educator.

The difficult task of the school administrator, to bring together those who teach and those who are taught in the most effective manner, is still complicated by the factor of constant change—but, with Hauserman flexibility, this task is made easier. ◀◀

plexiglas for glazing and light control

Rohm & Haas Company

PLEXIGLAS* acrylic plastic is a widely used glazing material for windows, skylights, doors and partitions in areas of high breakage in school buildings. Not only does PLEXIGLAS eliminate the needless costs and hazards of broken glass, it can also provide the solar control that gives the environment your teachers and students need. We suggest that consideration be given these factors of maintenance and environmental control in the specification of glazing in new school design.

Design for Maintenance

While the costs of vandalism have long plagued school administrators, it is only in recent years that cost studies have clearly defined the magnitude of these expenses. These studies consistently show that window breakage is far and away the highest single expense item from vandalism.

One research project into this subject was carried out during the 1963-64 school term by the Research Council of the Great Cities Program for School Improvement. Some typical annual cost figures for broken window replacement from this study are:

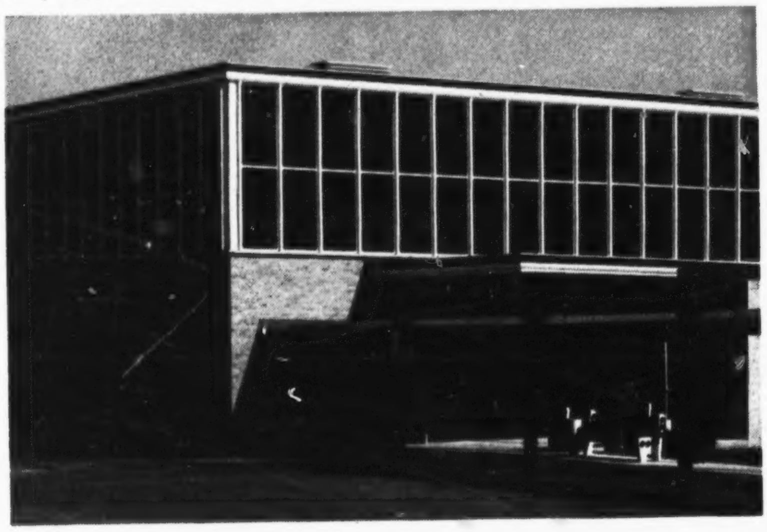
Baltimore, Md.	$105,590
Boston, Mass	$108,000
Chicago, Ill.	$747,425
Kansas City, Mo.	$ 54,076
Milwaukee, Wisc.	$ 46,579
San Francisco, Calif.	$ 98,892

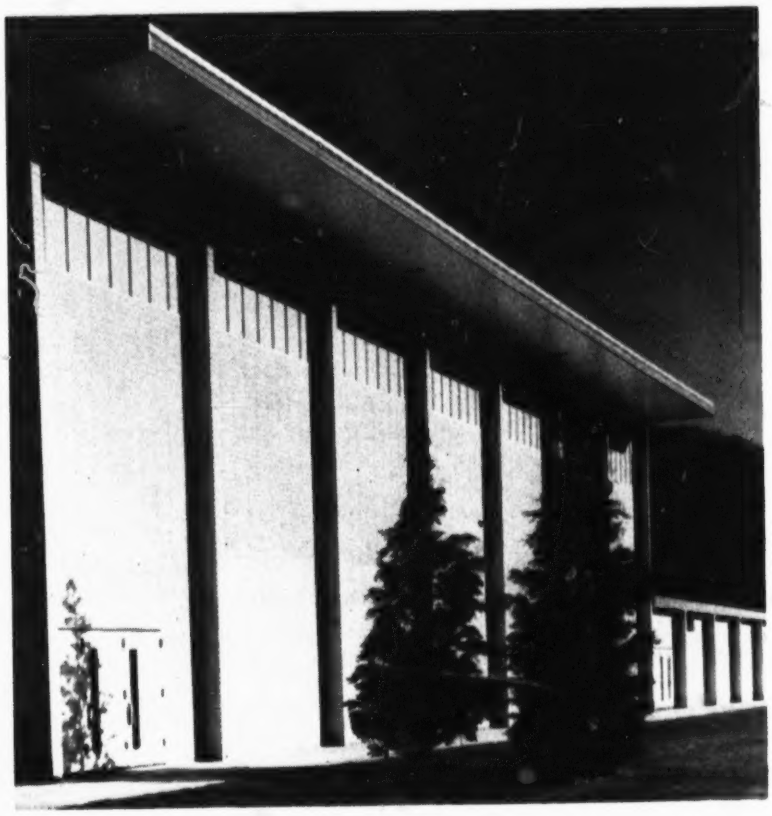
This tremendous expense can be greatly reduced, if not entirely eliminated, through the installation of highly breakage-resistant PLEXIGLAS glazing in new school construction or as replacement glazing in existing buildings. PLEXIGLAS is as clear as glass, rigid, light in weight, weather resistant and easy to cut and install.

While PLEXIGLAS is not unbreakable, it has considerably higher impact resistance than all types of glass, including one-quarter inch tempered glass. The results of a series of impact tests are shown below. The tests were conducted with a 7½" diameter, 6.685 pound wood ball

White, translucent Plexiglas was specified for high level glazing of gymnasium at Issaquah High School (right) because light transmission and solar heat control were important but see-through was not. Architects: Young Richardson and Carleton, Seattle.

Gymnasium glazing is application where impact resistance and solar light and heat control of Plexiglas have proved advantageous. Salisbury, Pa., Junior-Senior High School below is a typical example. The breakage resistance of Plexiglas eliminates the need for unsightly screens for protection. Architects: George Yundt Associates, Allentown, Pa.





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*Registered trademark of Rohm & Haas Company, Philadelphia.

with a steel center and a felt cover. Glazing test samples measuring 18″ x 24″ were mounted in a wood frame.

Impact Resistance

Material	*Thickness, ins.*	*Average Breakage Height of Drop, ins.*	*Average Impact Strength, lbs.-ins.*	*Average Speed of Ball at Impact, mph*
Dbl. Strength Window Glass	⅛	3.7	25	3.3
Laminated Glass	¼	16.5	110	23.0
Plate Glass	¼	16.5	110	23.0
Wired Glass	¼	16.7	112	23.0
Tempered Glass	¼	87.0	582	51.0
Plexiglas	⅛	98.0	716	54.0
Plexiglas	3/16	123.8	828	60.0
Plexiglas	¼	162.5	1,086	70.0

Considerations of pupil safety must be added to the elements of cost savings when evaluating the breakage resistance of PLEXIGLAS. Daily newspapers and safety journals regularly carry stories of students injured when they fell or were pushed into a glass door or window panel which broke. When PLEXIGLAS does break under severe impact, it generally breaks into large, dull-edged pieces, eliminating the sharp, dagger-like splinters that result when glass breaks.

These safety considerations are one of the reasons PLEXIGLAS is being widely used in interior partition glazing in schools. Another reason is the availability of PLEXIGLAS with a variety of surface patterns and in white translucent which provide privacy with little loss in light.

PLEXIGLAS is more expensive than glass—some two to three times more expensive than common window glass. But the School Seminar's concept, "Design for Maintenance," (see page 3), is a pertinent consideration here: "A low cost school is not always the most economical since real cost includes ultimate maintenance and operating expenses." Labor and overhead account for nearly 90 per cent of the true cost of window replacement and a PLEXIGLAS light, once in place, rarely needs to be replaced.

Design for Environment

PLEXIGLAS is available in a broad range of transparent bronze and grey tints to meet a variety of light transmittance, glare and solar heat control requirements. Glazing with these tints can make a great contribution to the creation of a comfortable environment conducive to study.

The table below shows the transmittance values of a range of standard grey and bronze tints.

Transmittance Values of Transparent Grey and Bronze Plexiglas

Color Number	*Total Solar Energy Transmittance*	*Light Transmittance*
Colorless	86%	92%
2094 Grey	62%	45%
2064 Grey	44%	27%
2074 Grey	32%	14%
2088 Grey	26%	9%
2370 Bronze	23%	11%
2412 Bronze	45%	25%

These colors transmit light almost evenly across the visible spectrum so there is little distortion of natural colors viewed through them. In these tints, light transmission values are the same irrespective of the thickness of the PLEXIGLAS.

Where see-through is not required, one of the variety of white translucent PLEXIGLAS sheets can accomplish similar controls.

Transmittance Values of White Translucent Plexiglas

	Total Solar Energy Transmittance	*Light Transmittance*		
Color Number	*3/16″ Thick*	*⅛″ Thick*	*3/16″ Thick*	*¼″ Thick*
2075	73%	79%	77%	71%
2067	66%	72%	68%	53%
2159	62%	67%	63%	43%
2254	59%	65%	60%	40%
2447	52%	56%	52%	36%
7138	37%	41%	35%	26%
7328	27%	32%	24%	17%
7420	18%	22%	16%	11%
7414	11%	14%	10%	9%
7508	8%	9%	6%	4%

White translucent colors reflect solar heat, accounting for their lower solar heat-light transmittance ratio. The light transmission of white translucent sheets varies directly with the thickness of the sheet while heat transmittance is independent on the thickness of the material.

Principles of Installation

Two characteristics of PLEXIGLAS must be considered when glazing with the material:

(1) It is subject to greater dimensional change, due to thermal expansion and contraction, than other materials with which it is used in construction. For example, it will expand three times more than the aluminum sash within which it is framed.

(2) It is not as rigid as many other building materials. This means it will deflect under load, foreshortening as a result of this deflection.

In outdoor glazing, where temperatures and wind loads vary, PLEXIGLAS should be handled in accordance with the following general recommendations:

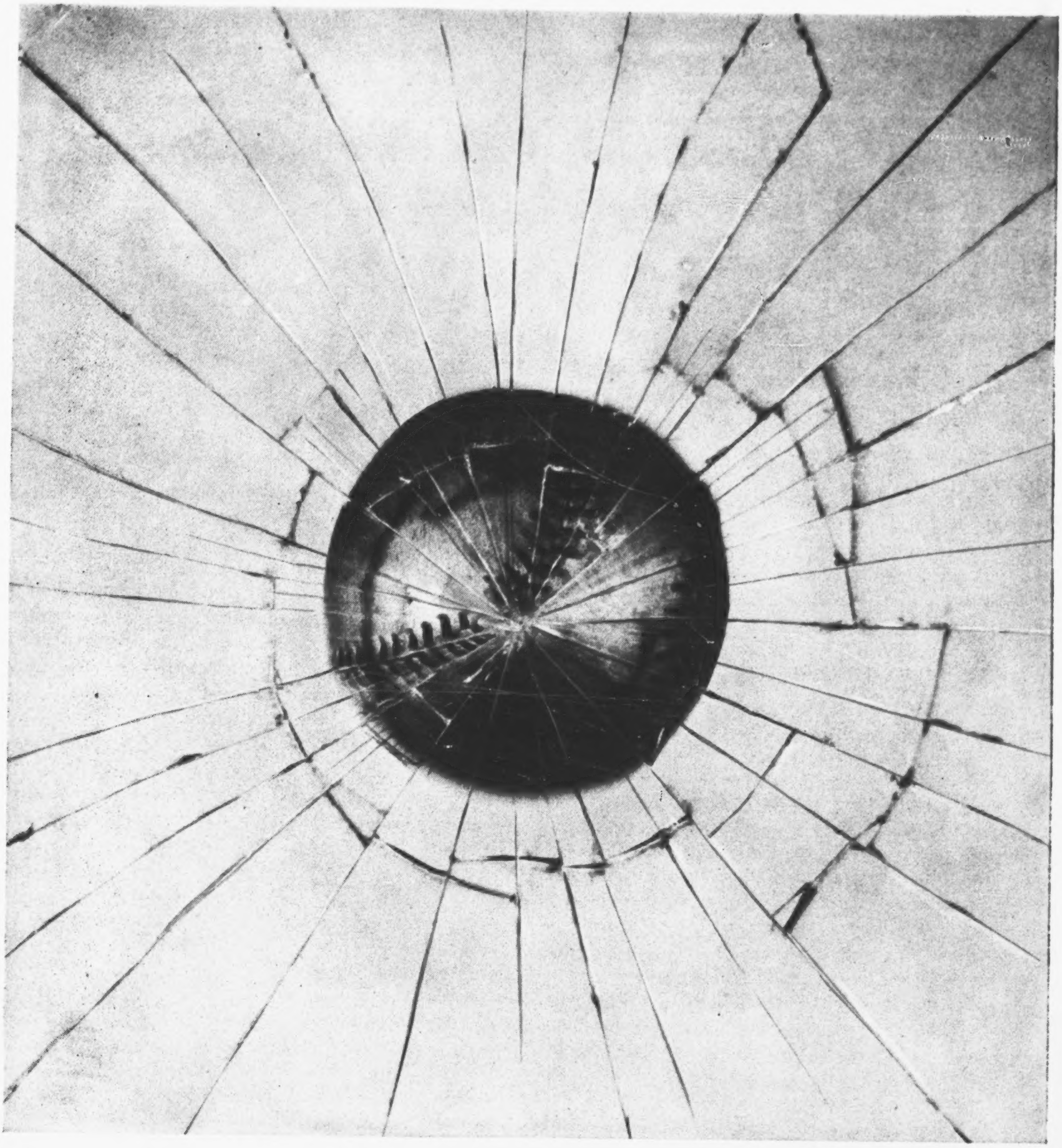
- PLEXIGLAS lights should be installed in a channel frame engaging the edges of the material so that it is free to expand and contract without restraint.
- Frame depth should be sufficient to allow for thermal expansion and contraction and foreshortening due to deflection under wind load without withdrawal of edges of the PLEXIGLAS from the frame.
- Before installation, PLEXIGLAS should be cut sufficiently shorter than the inside frame dimensions to accommodate thermal expansion.
- Sealant compounds and tapes should be types which are sufficiently extensible to accommodate the anticipated movement of the PLEXIGLAS.

Techniques of Installation

Generally, small glazing lights of PLEXIGLAS—those with major dimensions of 24″ or less—can be installed in any standard window sash, metal or wood, that has a minimum 5/16″ rabbet depth. Installation can be made with glazing points or clips and elastic (non-hardening) glazing compounds; or with metal or wood beads using elastic glazing compounds as a bedding for the light.

The installation of PLEXIGLAS lights with dimensions larger than 24″ requires slightly different methods than those used in setting glass.

Complete installation recommendations for all sizes of PLEXIGLAS lights can be obtained from any Rohm & Haas sales office or by writing Rohm & Haas Company, Philadelphia, Pa. 19105. Successful glazing depends on the careful observance of these recommendations. ◀◀



Prevent it!

Design to prevent the needless cost and danger of broken school windows.

Design to provide the solar control necessary to achieve the environment your teachers and students need.

Design with glazing of breakage resistant PLEXIGLAS® acrylic plastic, available in clear sheet and a wide range of tints, translucents and patterns to satisfy a variety of light transmission, glare and solar heat requirements.

To get complete technical information and data on sources of supply just write to Rohm & Haas Company.

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schools: high, wide, and handsome

JOHNS-MANVILLE CORPORATION

Schools no longer are fortresses. Today's architects are designing buildings that are light, airy and pleasing to the eye. They also are employing materials, systems and techniques that afford improved design, greater flexibility and low maintenance —materials that help provide a better physical and psychological environment for today's growing minds and ever-increasing enrollments.

Most of today's schools are being built as lightweight enclosures. These lighter structures, however, are subject to greater movement and, here, industrial systems of construction point the way in solving problems and reducing costs.

New Roofing

Smooth surface asbestos roofs, for example, save from 300 to 400 pounds dead weight for each 100 square feet over slag or gravel. For an even greater saving in weight, a one-ply roofing system was introduced by Johns-Manville within the past few years. Not only is it lighter but it also is better able to withstand the stresses encountered in modern roof design.

The roofing membrane of the system has a polyisobutylene base and is the product of long study at the Johns-Manville Research and Engineering Center, the largest in the building materials industry. Four basic components are involved: the roofing membrane, flashings, adhesives and a liquid finish coating that comes in a variety of colors. The adhesives, which are applied cold, and the one-ply membrane greatly reduce the risk of application errors.

The new system is bondable for up to 20 years except for the finish coating which can be reapplied easily with roller or brush.

New Walls

Still another development in school construction is the snap-in curtain wall. Such systems offer the benefits of economy, rapid construction and efficient insulation. They come in a variety of core materials and can be finished to suit practically any design preference.

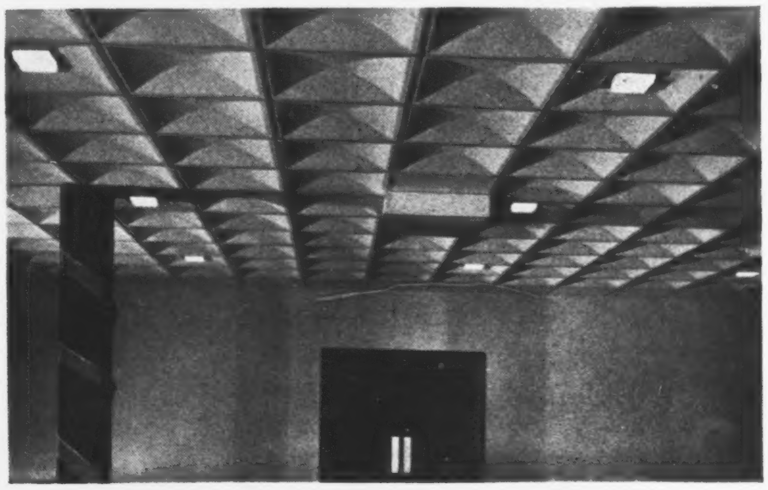
Various types of steel and aluminum mullion systems are available—some of them proprietary—and these permit erection of the panels to be handled with speed. Furthermore, the large size of the curtain wall panels permits the enclosure of big areas in a minimum amount of time.

New Ceilings

Acoustical ceiling systems today should be chosen to suit the rooms or areas in which they are to perform their function. The variety of acoustical products is great and many have their specific attributes.

Take, for example, one type with a metal surface and a mineral backing. Because of its bacterio-static qualities, this particular acoustical tile is especially suited for

Handsome roof on beautiful Beckman Auditorium at California Institute of Technology, Pasadena, uses one-ply roofing system with a polyisobutylene base. Architect: Edward Durell Stone.



This suspended acoustical ceiling of vaulted, lay-in panels can lend style to many types of rooms. The lightweight panels may lifted out to gain access to the area above.

"BETTER SCHOOLS BEGIN WITH BETTER BUILDING MATERIALS"

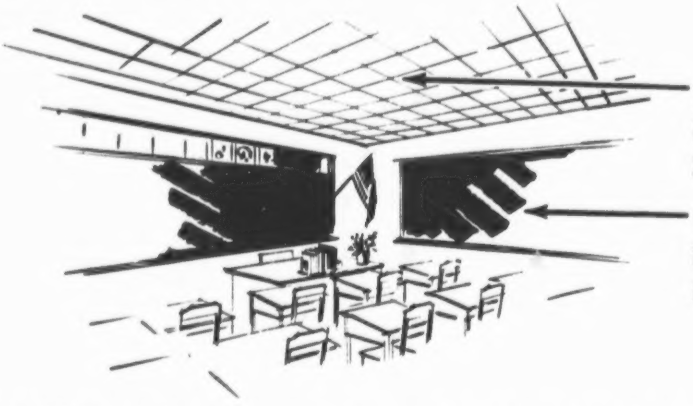
TODAY'S SCHOOL CONSTRUCTION

begins with

JOHNS-MANVILLE

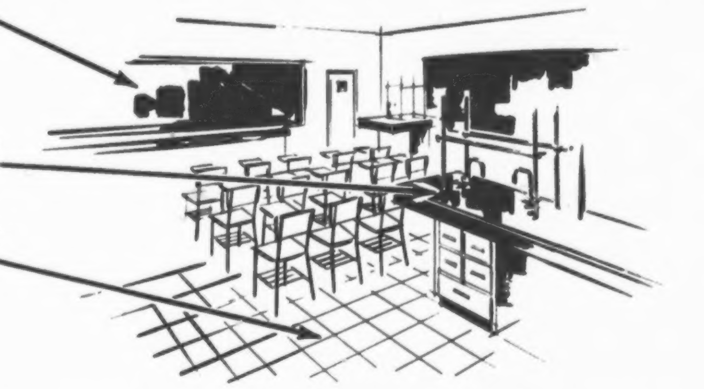
BUILDING PRODUCTS

Never before have Architects, Designers, Engineers and Contractors demanded the flexibility of materials, systems and techniques that they do for today's school construction. Johns-Manville meets this challenge with a continued flow of building materials that provide increased flexibility, improved design and ease of installation and maintenance.



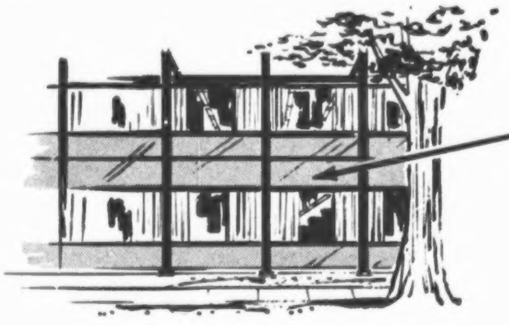
ACOUSTI-CLAD*—colorful, aluminum clad acoustical ceiling tile . . . can be installed by cementing or suspending . . . meets fire, moisture and wear requirements*

COLORLITH CHALKBOARD*—colorful, glare-free writing surface offers better visibility, longer service and easier maintenance*

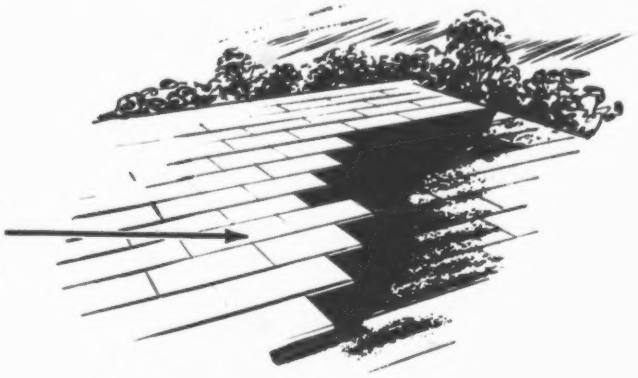


COLORCERAN *— smooth, durable surface for laboratory table tops, fume hoods and other hard working areas in schools*

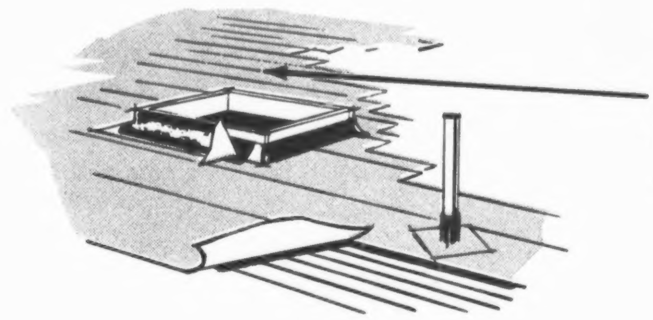
TERRAFLEX*—long wearing, vinyl-asbestos tile . . . enhances any school interior. Attractive, easy to clean, easy to install*



TRANSITOP *—prefabricated structural units that combine outside wall, insulation core and inside wall . . . all in one panel*



IMPROVED FESCO BOARD *—incombustible, moisture-resistant roof insulation made from perlite offers increased wind resistance, greater strength and long, dependable service*

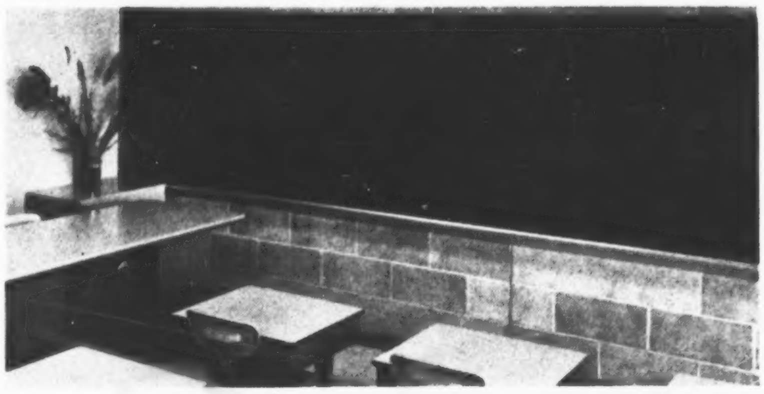


LAST-O-ROOF *— single membrane, cold application roof system for any slope or shape . . . for years of trouble-free service . . . rapid coverage*

For information on J-M Building Products, see your J-M Sales Representative or contact the nearest J-M Sales Office.

For over 100 years Johns-Manville has been a leader in the production of quality building materials and the Johns-Manville Research Center is the largest in the world devoted to the development of building materials. These years of experience in research and manufacturing enable Johns-Manville to offer the highest quality building materials on the market today.

JOHNS-MANVILLE, *22 East 40th Street, New York, N. Y. 10016*



Colorlith chalkboard, ready to use as soon as installed, gives good "tooth" without "drag" to avoid squeaks and squeals.

use in areas where cleanliness and sanitary conditions are the number one consideration.

This tile is widely used in kitchens and cafeterias, since it may be washed repeatedly without any danger of softening, peeling, cracking or warping and because it does not need repainting.

Noise is absorbed through tiny perforations in the metal surface, and the tile is available in a variety of pleasing colors that make it adaptable to almost any decor.

There are other ceilings that are highly decorative and are available in vaulted or coffered shapes to give rooms distinction while, at the same time, cutting down on noise. These are fiber glass lay-in panels installed in a suspended grid system.

There are still other suspended ceilings which are ideal for use in rooms where access must be provided to mechanical equipment above or where the system must adapt to changes in arrangement of partitions and lighting. Suspended ceilings with lay-in panels are being called upon more and more to meet these needs.

And, last but not least, there are perforated TRANSITE panels (J-M's registered name for its brand of asbestos-cement products) which are excellent for use in gymnasiums, where rough wear and abuse are expected, or in swimming pool locations because they are not affected by dampness.

New Floors

Vinyl-asbestos floor tile, long one of the most popular and practical of floor coverings in schools, today comes in new and attractive patterns and colors. The trend has gone from straight marbleized patterns to all-the-way-through chip designs and swirl marbleized patterns.

Since vinyl-asbestos tile was originated by Johns-Manville in 1933, its beauty and practicality have caused it to win greater and greater acceptance. Industry-wide production has more than doubled in the past five years.

Vinyl-asbestos floor tile is widely accepted for its low initial cost and its ease of maintenance.

Ease of Maintenance

No material is entirely free of maintenance, of course, but a minimum is desirable from the standpoint of cost. Two things should be kept in mind: first, maintenance should be the kind that for the most part can be handled by unskilled staff employees without special tools or equipment and, second, that the initial savings on cheap products usually are cancelled out by subsequent maintenance costs.

For example, new school chalkboards made of asbestos and cement perform yeoman's service all across the land. Negligible chalk build-up makes frequent washing unnecessary. Stains can be removed with household cleaning agents such as a detergent-type abrasive cleaner or chlorine bleach. Highly pigmented colored chalks that do not erase dry can be removed with clear water or cleanser. Otherwise, washing requires only clear water.

Laboratory table tops, too, must withstand not only physical abuse but also chemicals. Here, again, asbestos-cement sheets with a special finish in a number of colors require little care.

Exterior maintenance is equally important. For example, a roof that is properly designed and maintained will last for more than 20 years. Johns-Manville reports that some of its roofs have lasted up to 40 years, and recently a customer wrote to say that he still was getting good service out of a smooth-surface roof applied 54 years ago. The roof has been recoated only once since it was installed.

In this connection, a non-absorbent, compression-resistant roof insulation is essential to support the roof membrane. Soft compressible insulation invites damage to a roof.

One such material, an insulating board made of perlite, has recently undergone manufacturing changes that have improved greatly what already was a widely respected product. Perlite is volcanic ore which, when exposed to tremendous furnace heat, expands to form tiny glass-like beads.

The board has always been incombustible, non-absorbent and resistant to compression. However, the new improved product has a reduced bitumen absorption level, greater laminar strength and resistance to compression, and greatly improved wind uplift resistance. A lasting resistance to heat transmission also is assured with the new board when it has been applied correctly, and it provides permanent support for the roof membrane.

When we speak of today's better school environment we run the gamut of all these products and systems. A watertight roof has always been the number one requirement. It still is, but now the job is being done better. Thermal comfort is vital, too, but this, like a sound roof, we almost take for granted.

Our forebears learned their ABC's in rooms that lacked acoustical treatment. We realize today that quiet rooms are conducive to learning. We are aware that flooring should be decorative, quiet and safe. We know that working light should be good and that chalkboards should be free of glare.

All these things are attainable today with materials that provide flexibility, ease of maintenance and improved design—materials that work for the school with the student always in mind. ◀◀

low maintenance with a preformed film

E. I. du Pont de Nemours & Co., Inc.

The use of prefinished building products in school construction has increased significantly in recent years because of the need for better surfacing materials and because of the savings in on-site time and labor costs provided by these products. Now a new and totally different kind of prefinish—a preformed, pre-tested film—is available for surfacing building products used in school construction. This product, developed by Du Pont, is called TEDLAR* PVF film. It possesses a combination of properties that are unique by comparison with any other plastic film or prepaint system, the most outstanding of which is its permanence when exposed outdoors.

What is "Tedlar" PVF Film?

Not a liquid or spray, TEDLAR is a weatherable, tough, inert, film which is available in both transparent and pigmented forms. Bonded to building materials at the time of manufacture, it provides a surface of high tensile strength, flexibility, and abrasion resistance—a finish that stands up to sun, wind, rain and the destructive forces of nature for many years with minimum maintenance.

Available in a dozen medium lustre colors, pigmented TEDLAR is a durable, fade and chalk resistant finish which has a useful life outdoors significantly longer than conventional finishes. This is possible because the film former and the binder for the pigment is the inert polyvinyl fluoride, a material that does not deteriorate or discolor with exposure. Consequently, chalking and surface erosion are minimal.

Transparent TEDLAR PVF film exhibits a smooth, nonporous surface, completely inert to a wide variety of chemicals, solvents and staining agents. Laminations of this film to decorative substrates are finding wide use in interior applications where cleanability and stain resistance are desired.

The Film Finish Concept

Finishes must do two jobs: *protect* and *bond* to the base material. When one material must do both, as with liquid finishes, neither is done as well as it might be and compromise results.

In film finishing, these two functions are handled separately. A preformed film is designed to protect; special adhesives, also developed by Du Pont, are designed to bond. Consequently, optimum performance is attained in each area.

In addition, prefinishing with a film has other distinct advantages:

(1) The film can be "tailored" to specific end uses.

(2) It is pre-tested for important properties such as color match, uniformity, freedom from pinholes, and thickness. These are all checked at the time of film manufacture and controlled to rigid tolerances.

(3) The performance of the finish is predictable. Resistance to weathering, mechanical and chemical properties, etc., are basic film characteristics which are known and are checked regularly.

(4) Film finishing is adaptable to both flexible or rigid materials.

Characteristics

Some typical properties of a 2 mil thick (.002") TEDLAR PVF film are:

Tensile Strength:	9000 psi minimum
Elongation:	100%+
Water Vapor Permeability:	less than 1 perm
Flex Life:	70,000 cycles at 70°F
Chemical Resistance:	No common solvent
Color Match:	$\Delta E \leq 0.5$ NBS Units
Functional Temp. Range for Continuous Exposure:	—100°F. to +225°F.
Flammability:	Self-extinguishing

Weatherability—More than 20 years of outdoor exposure and laboratory testing indicate that polyvinyl

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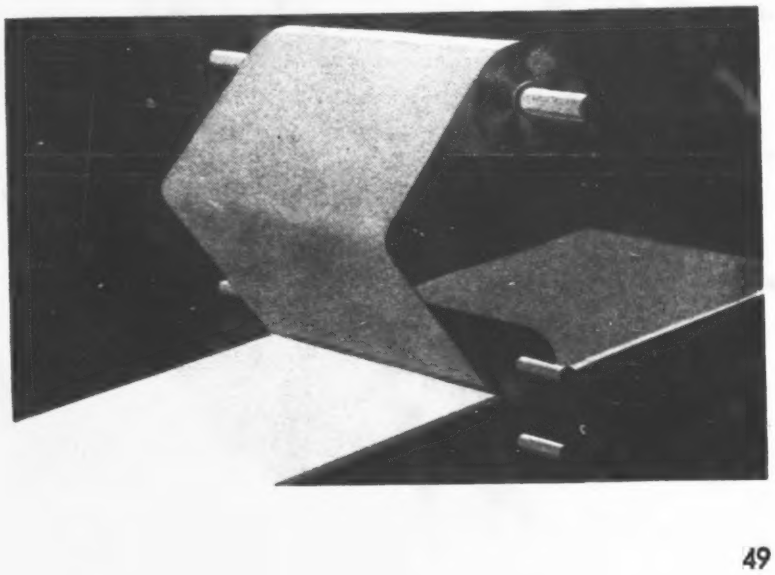
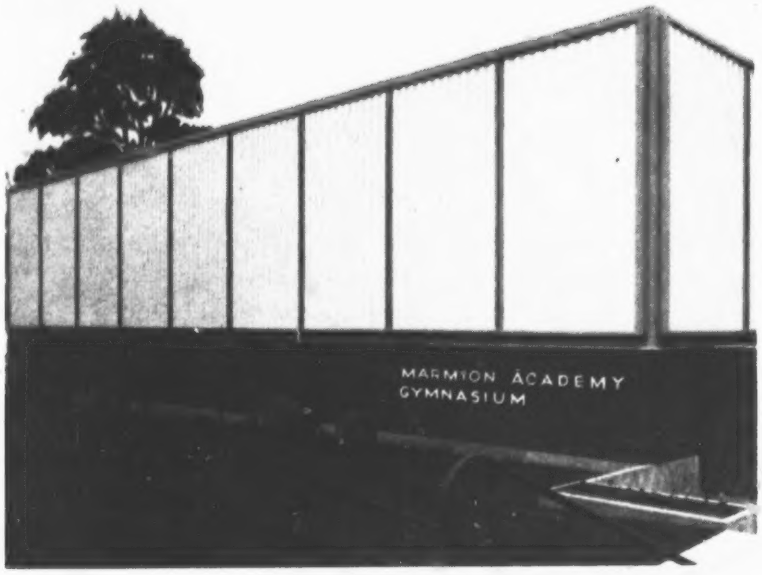
*Du Pont registered trademark

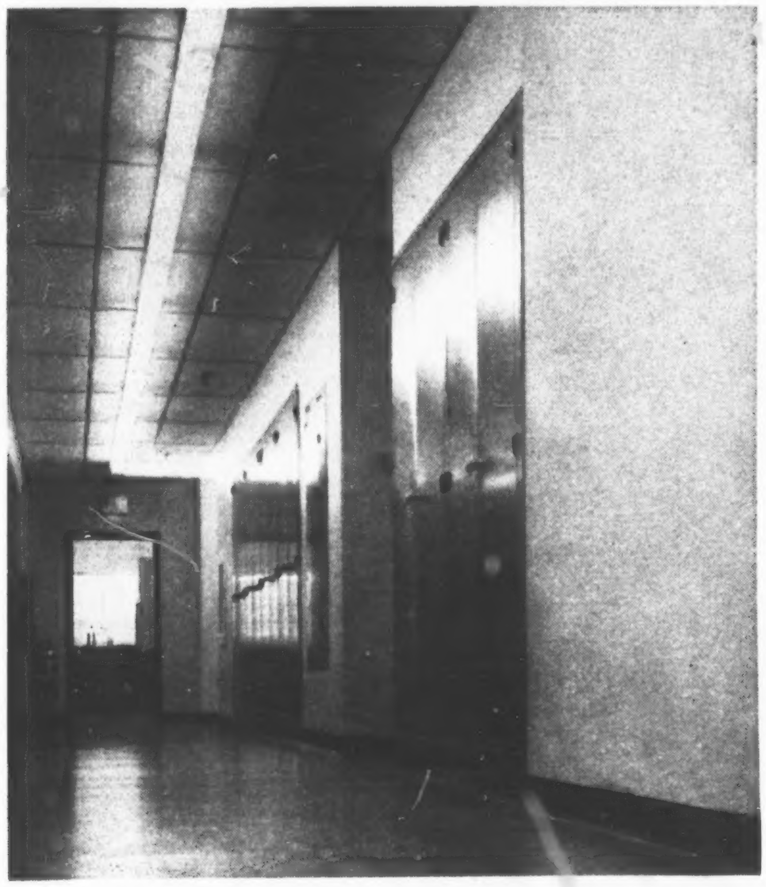
Prefinishing with TEDLAR PVF film



TEDLAR PVF FILM: . . . for roofing



. . . for architectural panels



. . . for wall covering

fluoride film has remarkable resistance to degradation from sunlight and moisture. The polymer is essentially transparant to, and unaffected by, solar radiation in the near ultraviolet region of the spectrum. In pigmented film, this property provides a surface with unique resistance to fading and chalking. Tests comparing the degree of fading as measured in NBS units indicate that the film will retain its original appearance several times longer than the best organic finishes.

Toughness—TEDLAR PVF film is strong, flexible and fatigue resistant. When used as a finish, the film provides a high resistance to chipping, cracking, crazing, damage from impact, handling, sandstorms, etc. It will also withstand a wide range of fabricating operations such as embossing, shearing, roll or brake forming and thermoforming.

Inertness—The film is chemically inert—boiling acids, caustic, solvents, corrosive fumes have no effect on it. It is impermeable to greases and oils and its properties were unaffected by bacteria after five years soil burial. It also has excellent resistance to hydrolysis: strength, yield stress, and elongation were not measurably affected after 60 hours in 85 psig steam (325°F.).

Types of Applications

Roofing—Laminated to asbestos felt, TEDLAR PVF film provides a one-ply roll roofing membrane with several unique benefits:

(1) Lasting Appearance: The weatherability of TEDLAR PVF film provides an erosion and chalk-resistant smooth surface. There are no pores to trap dirt.

(2) Inert and Permanent Whiteness: The surface is unaffected by chemicals and solvents and does not yellow.

(3) High Reflectivity: The coefficient of solar absorptance is 2½ times less than marble chips. This improves air-conditioning efficiency, minimizes thermal shock.

(4) Light Weight: This roofing system is many times lighter than a standard built-up roof and the material is easy to transport on the job.

(5) Conforms to Any Shape Roof: It adapts to flat, steep pitch, or compound curve roof designs.

(6) Low Maintenance and Ease of Repair: The combination of film properties gives the lowest cost per year of service.

Architectural Panels—Wall panels surfaced with pigmented TEDLAR PVF film retain their original appearance significantly longer than those prefinished with conventional paint. Outdoor exposure tests indicate three to four times greater resistance to fading and chalking. The initial color match and color stability after weathering permit buildings to be altered or enlarged in later years without obvious loss of color continuity. The long life, abrasion resistance, cleanability and stain resistance of TEDLAR also significantly reduce maintenance expense and provide a high "value in use."

Wall Covering—A surface of clear polyvinyl fluoride

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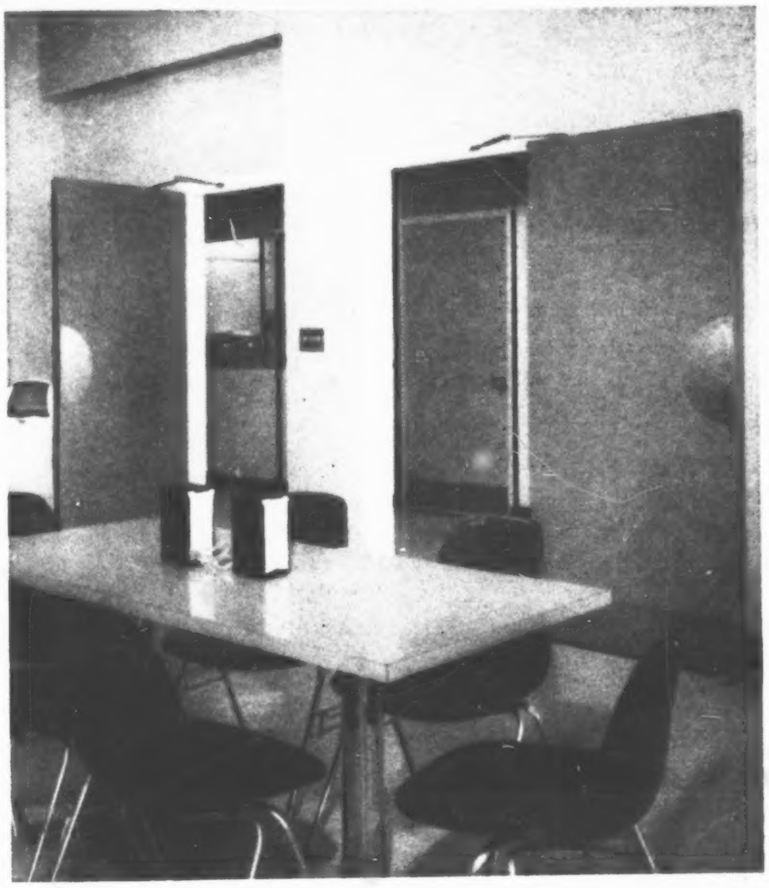
*Du Pont registered trademark

. . . for fiberglass reinforced plastic panels



. . . for doors

film on flexible vinyl wall covering provides stain resistance equal to ceramic tile. Because of this chemical inertness, difficult stains (such as ballpoint pen ink, lipstick, nicotine, shoe polish, and marking ink) can be easily wiped off. Strong cleaning agents like toluene and acetone can be used without affecting the surface. Savings are realized from reduced maintenance without costly and inconvenient tie-up of facilities.

Fiberglass Reinforced Plastic Panels—Fiberglass reinforced plastic panels surfaced with polyvinyl fluoride film have shown marked improvement in outdoor life over conventional panels. The film protects against surface erosion and fibre exposure; improves gloss retention; minimizes discoloration and dirt collection; maintains light transmission.

Doors—Flush exterior and interior doors surfaced with TEDLAR PVF film are available for commercial installations. The tough film finish is particularly well suited for high-traffic areas where abrasion resistance and stain resistance are important. The ease with which stains and dirt are removed from TEDLAR is a significant advantage derived from the chemical inertness of the film.

Lighting Panels—The ability of TEDLAR to resist degradation by ultraviolet light has extended the useful life of polystyrene lighting panels. Accelerated tests indicate that polystyrene surfaced with TEDLAR will not change in appearance or yellow after many years of actual use. In addition, the stain-resistant qualities make the surface of these panels easy to clean.

Other commercially available products which are prefinished with TEDLAR include: residential type siding (wood and metal); insulation jacketing; insulated sandwich wall panels; and architectural facing systems.

Benefits With Tedlar

In summary, TEDLAR PVF film is an ideal surfacing for building products used in school construction because of its:

- *Toughness*—Its strength and elongation provide a scratch and abrasion resistant surface that will not chip, crack, or craze.
- *Economy*—Based on its long life under all types of exposure conditions, it is one of the most economical finishes you can buy.
- *Durability*—Since it is one of the most weatherable organic finishes known, it will provide long term protection to the substrate. In addition, Du Pont has developed adhesives which develop a bond so strong and permanent that TEDLAR actually becomes a part of the base material. The film will not blister or delaminate.
- *Low Maintenance*—Chemical inertness permits cleaning, which is needed only occasionally, with any material without harm to the finish.
- *Appearance*—Colors are uniform and stable. Due to its inherent resistance to UV degradation, TEDLAR will undergo only minimal surface change with exposure. This provides lasting beauty and permits future additions without refinishing the existing structure.
- *Reliability*—TEDLAR quality is assured because the important features of a finish are checked before lamination. In addition, the laminate with this pre-tested finish has known, reproducible performance. ◀◀

Additional information about TEDLAR PVF film may be obtained by contacting the Du Pont Company, Film Department, Building Materials Sales Division, Wilmington, Delaware 19898, or Du Pont offices in Chicago, Cleveland, San Francisco, New York City, and Philadelphia, Pennsylvania.

lighting for learning areas

Curtis-Electro Lighting, Inc.

Contemporary architectural design has reached a level of proficiency that provides complete control of the thermal and visual environment in learning areas—and as a result, outside variations of weather and sunlight no longer disrupt or affect the learning process.

However, although the control of thermal environment is a matter of mechanics, control of visual environment is more subtle. The psychological and physical aspects of vision are quite complex relative to the ability to see; but since vision accounts for about 85% of the learning process, the lighting industry has plowed considerable effort into research to pinpoint the criteria which require special attention and treatment in order to produce the best possible visual environment.

The researches of Dr. Blackwell (Director of the Institute for Research in Vision, Ohio State University) indicate that, in general, lighting levels have to be doubled to overcome the effects of reflected glare alone on the seeing task. This fact makes it quite clear that *quality*—and not *quantity* alone—measures the worth and efficiency of a lighting installation. Accordingly, the American Institute of Architects, the National Council on Schoolhouse Construction, and the Illuminating Engineering Society, joined to produce a "guide" tailored to provide the criteria for a controlled visual environment best suited to modern learning area design and teaching techniques. Such a document—called the *American Standard Guide for School Lighting*—was published in 1962. This 40-page guidebook is gaining greater acceptance daily, as more national school administrators and state officials become aware of the excellent results that are the consequence of the application of the principles involved.

Basically, the *American Standard Guide* does not dictate specific amounts of illumination; therefore the widest possible latitude for a lighting budget exists. Instead, the guide does provide measuring devices and data, such that considerations for quality of lighting assures maximum vision per unit of lighting level. These measuring devices screen out glare and distracting brightness-ratios in the normal field of vision—two negative elements which impede the learning process. Upper and lower limits are established for reflectances of the finish on ceilings, walls, floor and furniture, and a Scissors Curve establishes acceptable ranges of luminaire average brightnesses. The recommended reflectances will result in balanced and acceptable brightness contrasts within the visual surround, for maximum visual comfort; yet there is plenty of design latitude for color and changing brightness levels to provide vitality and individual design expression (Figure 1).

The Scissors Curve guides the selection of luminaire types—where any luminaire that meets Scissors Curve criteria automatically becomes an integrated part of a luminous environment that has no distracting glare. Thus

Alzak Aluminum Luminaires provide ideal high level illumination for learning areas, offer maximum visual comfort.

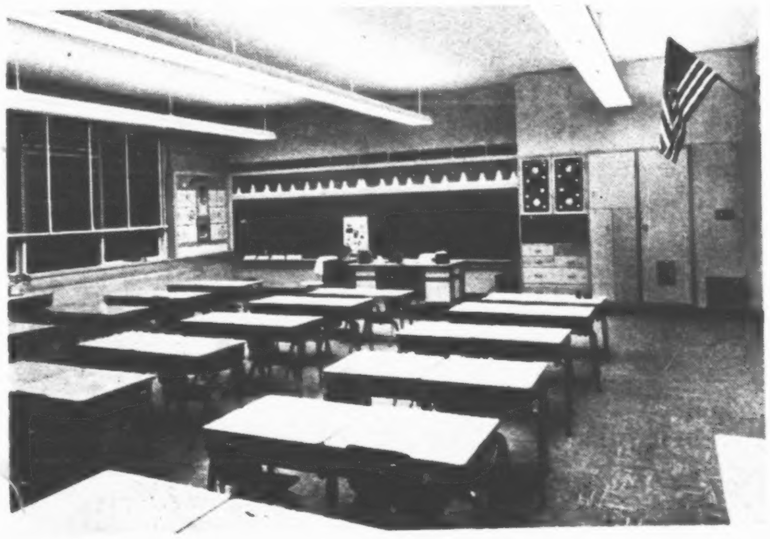
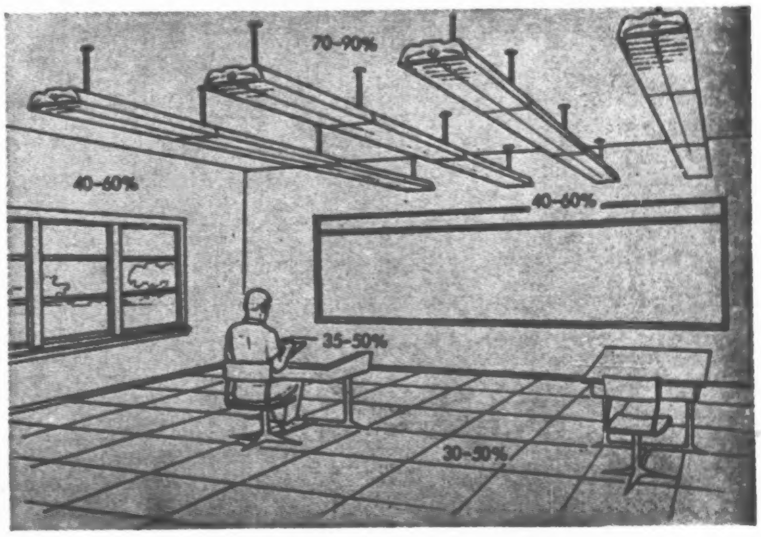
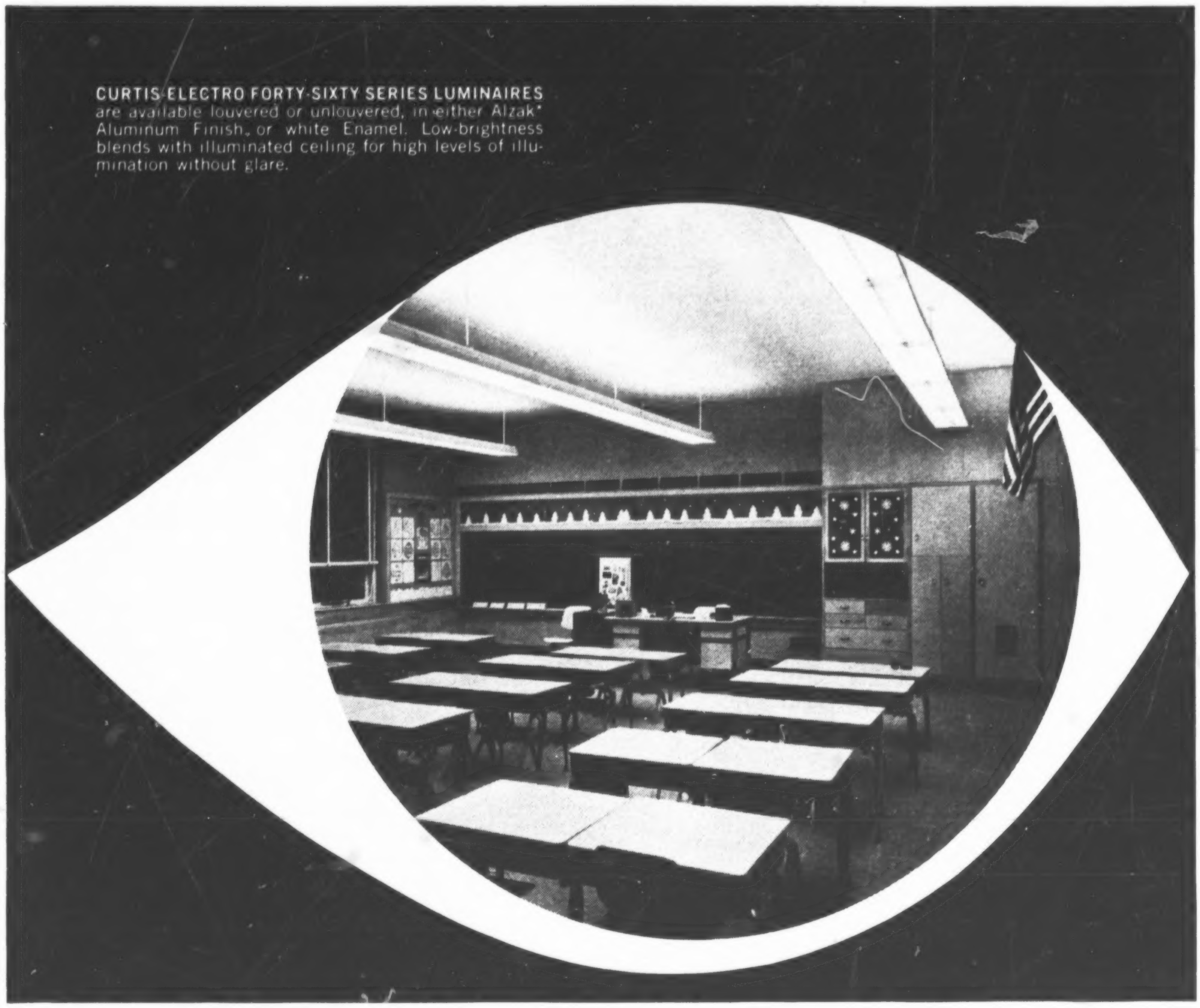


Figure 1. Typical lighting layout for 30' x 30' room with recommended reflectances for surfaces and furnishings in the learning area.





CURTIS-ELECTRO FORTY-SIXTY SERIES LUMINAIRES are available louvered or unlouvered, in either Alzak* Aluminum Finish, or white Enamel. Low-brightness blends with illuminated ceiling for high levels of illumination without glare.

"Brightness Ain't Light"

Pardon our grammar, but we wanted to be sure you got our message . . . that high level illumination is obtainable in schoolrooms without glare. A common misconception is that a well lighted room is synonymous with bright light, and this is not so. High level illumination, with low brightness, and no glare are the lighting results you get from a Curtis-Electro 40/60 Alzak Aluminum fixture . . . a fixture designed to provide today's finest and most comfortable schoolroom lighting. The Alzak Aluminum fixture retains its reflecting qualities for a lifetime and provides high level illumination with maximum visual comfort . . . an ideal combination for school lighting because it is lighting that is easy on the eyes. Get the higher levels of comfortable illumination into your schools with the Curtis-Electro 40/60 fixture . . . a fixture that puts the footcandles there without glare.

CURTIS-ELECTRO LIGHTING, INCORPORATED
1536 SOUTH PAULINA STREET, CHICAGO, ILLINOIS 60608
MANUFACTURING FACILITIES:
1536 S. Paulina St., Chicago, Ill. 60608 • Spruce and Water Sts., Reading, Pa. 19603 • 9009 Directors Row, Dallas, Texas 75247 • 140 Cherry St., Brooklyn, N.Y. 11222

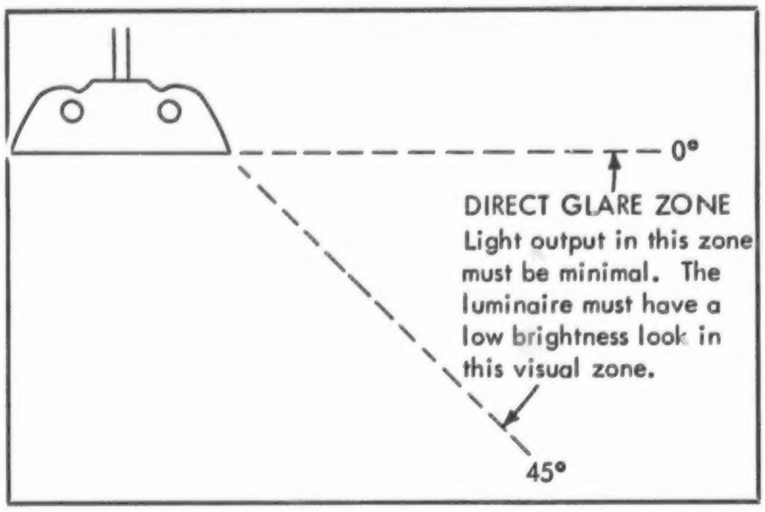

0°
DIRECT GLARE ZONE
Light output in this zone must be minimal. The luminaire must have a low brightness look in this visual zone.
45°

Figure 2. Eye comfort zone provided by good lighting.

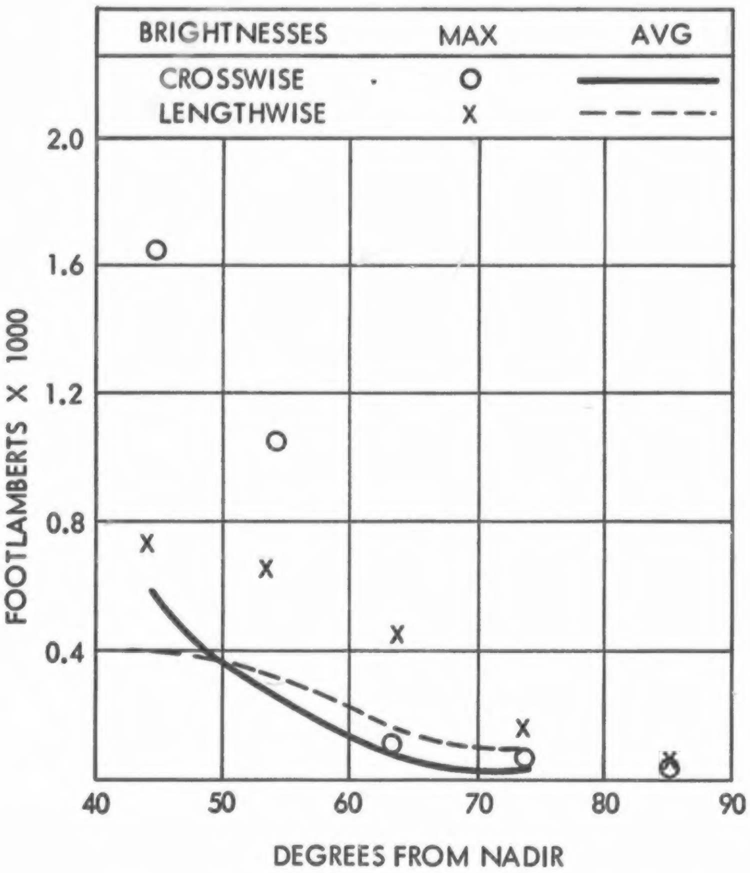


Figure 3. Brightness data from typical photometric report.

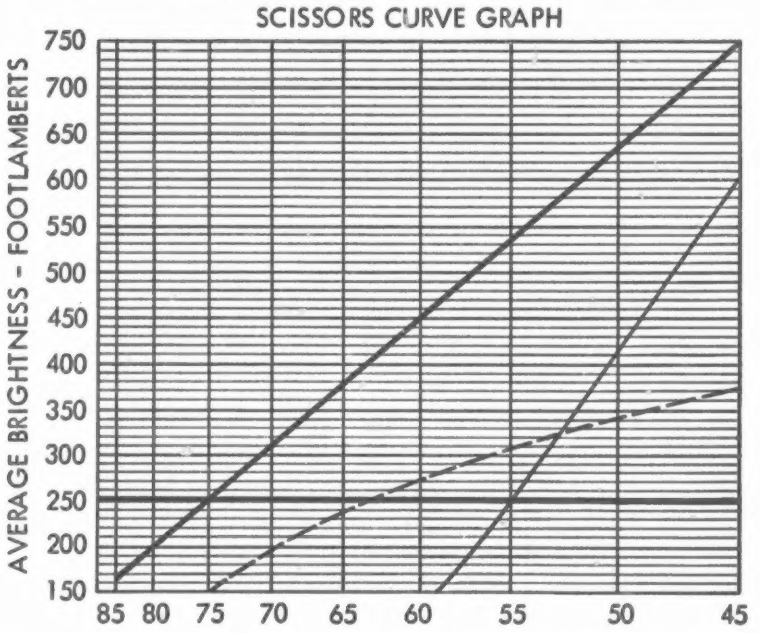


Figure 4. Brightness data from Figure 3 showing compliance with Scissors Curve. Crosswise brightnesses—solid line. Lengthwise brightnesses—dotted line. Compliance requirements are satisfied when each line falls below any straight line drawn through 250fl at 75 degrees between the sloping and horizontal lines. Crosswise and endwise brighness lines need not fall below the same limiting guide line.

any selected level of illumination produces maximum visibility, whether it averages 70 footcandles or more.

Figure 1 shows a typical 30′ x 30′ learning area which, with white ceiling and light walls within recommended reflectance ranges, requires four 24-foot rows of a 2-lamp, 40-watt, rapid-start lamp luminaire to produce 70 footcandles of desk level illumination. The number of luminaires required for the 70 footcandles was obtained by substitution into the expression:

$$(a)\ FC = \frac{\text{lamp lumens x coeff. of utilization x MF}}{\text{area in square feet}}$$

where the coefficient of utilization and maintenance factor are supplied by the manufacturer of the luminaires.

The luminaire which will provide the 70 footcandles established above is one that is known to be the best choice for most comfortable and most efficient lighting in a learning area: a pendent luminaire having parabolic-contoured reflectors of Alzak aluminum—a sample of which is demonstrated in the accompanying display. This type of luminaire utilizes the geometry of the parabola to produce the "low-brightness" effect, by controlling the output of light into the working zones, and away from normal viewing angles.

The precision of the parabolic reflectors is insured by the locked-in life-time reflectivity of Alzak-finished aluminum. This efficient "low-brightness" control of luminaire light output is instantly apparent by the contrasting finish of the display unit. The white enamelled steel finish is much brighter and more distracting to the viewer than is the Alzak aluminum portion—which, by nature of its low-brightness, blends in with the overall luminous environment of a learning area without glare.

Figure 3 shows an extract from a typical photometric test report, showing average brightness data in footlamberts, covering the luminaire described in this paper. It is this average brightness data, covering the angles of from horizontal to 45 degrees—the direct glare zone—that is superimposed on to the Scissors Curve. Figure 4 shows the result of the charting of the average brightness data of the specific luminaire involved in formula (a)—and as is apparent, the two-lamp 40-watt parabolic Alzak luminaire has met the Scissors Curve criteria.

The choice of aluminum as the basic material is decided by more than just the two principal factors of high reflectance (luminaire efficiency), and low-brightness. Aluminum is non-ferrous; therefore the school maintenance program is never concerned with rusting parts or peeling paint. Alzak aluminum never needs cleaning other than mere wiping, and the original efficiency never decreases. Alzak finished aluminum is ideal in chem labs or any other areas where fumes and chemicals are present.

At this point it becomes apparent that school administrators can be assured that, when it comes to lighting, present techniques as utilized by architects and designers can and do provide learning areas with luminous environment of the highest quality. Regardless of the level selected, today's learning area is truly the ideal site for the learning process. ◀◀

floors for use and abuse

Azrock Floor Products

In school construction, floors too often are given last consideration. Yet day in, day out they receive more abuse and wear than any other interior finish material in a school. For greatest satisfaction, architects and administrators should consider carefully the selection of the type of flooring to be used in educational buildings.

Four basic points are to be considered: color and styling, ease of maintenance, durability, and cost. There is available an infinite variety of floor coverings, each designed for a selected use. However, one flooring which can be used virtually anywhere inside the school is vinyl asbestos tile. The versatility and value of this product has helped to establish it as the most widely used flooring in schools today—surpassing asphalt tile which had been the most popular for many years.

Vinyl asbestos tile is made of vinyl resin, asbestos fiber, inert filler, and color pigments. The clarity and virtue of vinyl resin combined with the strength, durability and fire resistance of asbestos produce a flooring with a great variety of clean fresh colors that meet most decorative requirements as well as the very necessary functional requirements.

Color Important to Environment

Color and styling are vitally important in establishing a school environment conducive to learning. To meet this requirement, approximately 100 colors in many unusual and interesting styles have been created in vinyl asbestos tile. Among them is a relatively new style called the "Premiere Series," which is particularly suited to school installations. This series has a travertine-effect styling with a smooth surface. Its pattern is "broken" for easy maintenance, yet the series includes attractive colors which are light enough to attain high light-reflectance values as measured by the Photovolt Reflectance Meter. Other new and interesting color-chip patterns in vinyl asbestos appropriate for schools are Azrock's 800 Series and Cortina.

A fast growing development in vinyl asbestos is 12″ x 12″ modular size tile. Heretofore, 9″ x 9″ tile was the only size readily available. The 12″ x 12″ modular size is now being manufactured in a wide selection of colors and styles in response to architectural demand for units that conform to construction modules

LIGHT REFLECTANCE VALUES

AZROCK Vinyl Asbestos Tile

Pebbled-Onyx	
VP-626	69.3%
VP-627	62.5
VP-624	61.8
VP-625	56.5

Pebbled Terrazzo	
VP-393	59.0%
VP-395	57.1
VP-394	54.5
VP-392	49.5

Cortina	
V-346R	64%
V-304R	62
V-312R	60
V-341R	57
V-340R	56
V-342R	41
V-332R	39
V-337R	33
V-333R	31
V-338R	26
V-331R	24
V-330R	20
V-334R	19
V-310R	4
V-300R	4

Cork Hues	
V-381	36%
V-380	25
V-379	15

AZROCK Vinyl Asbestos Tile

Opaque Marbles	
V-348	66.5%
V-349	64.6
V-347	34.9

Premiere Series	
VM-461	63.5%
V-418	63.1
V-422	63.0
V-423	62.5
V-421	61.0
V-424	61.0
VM-462	60.5
V-425	60.0
V-428	53.0
V-426	43.5
V-419	42.7
V-427	41.0
V-417	39.4
V-429	30.5

Carpet Tones	
VM-241	68.5%
VM-242	66.5
VM-243	48.0

AZROCK Vinyl Asbestos Tile

800 Series	
VM-831	60.1%
V-812	59.5
VM-832	56.3
V-816	55.0
V-814	47.5
V-811	43.5
V-819	43.0
V-817	42.0
V-813	37.5
V-815	17.5

Terrazzo Originals	
V-366	67.7%
V-365	56.0
V-364	55.0
V-363	52.0
V-362	48.5
VM-371	43.0

Wood Tones	
V-355	60.0%
V-351	42.4
V-352	36.0
V-353	22.5

AZROCK Asphalt Tile

Marble Tones	
D-68	56.2%
C-79	49
D-66	43
D-61	40
C-42	39.2
C-78	37
C-71	35
C-57	32
C-59	26
D-65	26
C-73	25
D-54	25
C-52	24
C-43	21.6
C-46	21
C-44	19
C-72	13
C-63	9
B-33	7
B-23	7
B-21	4

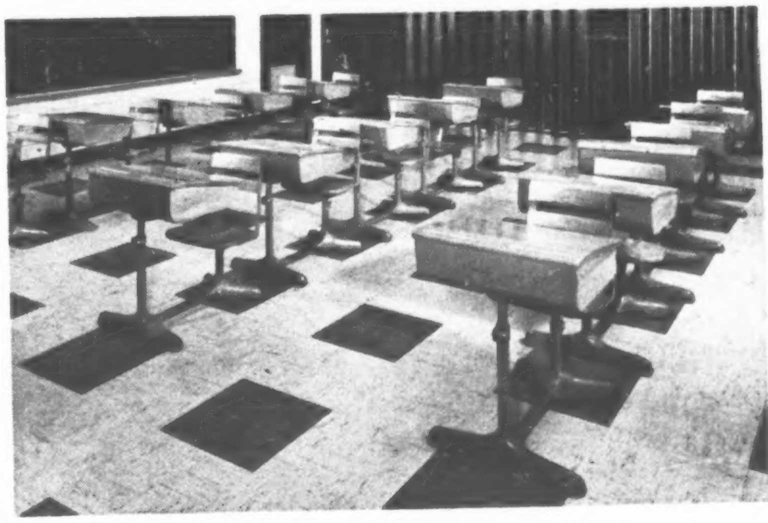
Terrazzo Tones	
C-571	34%

Cork Hues	
K-551	34%
K-552	28
K-553	18

Carpet Tones	
K-596	48.5%
K-592	44.5
K-593	35.5
K-591	35.0

Wood Tones	
D-81	39.1%
D-82	35.4

Tile lends itself to functional design. Squares in floors of St. Theresa School, Palatine, Ill., serve as guide for quick positioning and alignment of desks after maintenance. Floor is Azrock vinyl asbestos tile.



being used in other building materials. Also, this modular size allows easier correlation with design effects in wall, ceiling and other decorative elements.

Because the product comes in convenient tile form, floors can be created with special designs or accents to serve either decorative or functional purposes: to "welcome" students and visitors at the school entrance; to "widen" narrow corridors; to "direct" traffic flow.

Low Initial Cost and Maintenance

While initial cost is still a major factor in the selection of school flooring, increasing labor costs make it essential to consider the maintenance and replacement factors carefully also. First, vinyl asbestos is low in initial cost. It is lower than rubber, cork, or "solid" vinyl tile, terrazzo or wood, and significantly lower than carpet. Only asphalt tile is lower and maintenance savings quickly recover this small difference. Second, vinyl asbestos is low in maintenance cost. A recent year-long study at Summit High School, Summit, N. J., indicates cost to be 8.1¢ per foot. Because it has a tightly knit composition, dirt can't penetrate the surface. It stays up on top where it can be easily swept away. This, in turn, requires less scrubbing and floors can be kept clean and attractive by a regular program of dry buffing supplemented by periodic washing or occasional waxing. In addition, vinyl asbestos is impervious to grease and oil, and resists alkaline moisture and common chemicals. In domestic science kitchens, cafeterias, cafeteria kitchens and science laboratories, vinyl asbestos tile is unaffected by the common abuses that exist.

The versatility of vinyl asbestos tile makes it unnecessary to use different types of flooring materials in special use rooms. This, in turn, simplifies maintenance procedures, reduces the variety of cleaning products and equipment needed and brings further labor savings.

Third, while vinyl asbestos is low in initial cost and maintenance costs, it also has an established record of long life and trouble-free service in schools. Because vinyl asbestos has great structural density, its wear resistance or durability is exceptional. Vinyl asbestos resists abrasion effectively; therefore, under the same conditions it will generally have a substantially longer life than most other resilient or soft floor covering. It can be installed in areas subject to severe traffic such as school entrances, stair landings or under desks. The patterning in many of the stylings is distributed through the full thickness of the tile and therefore "can't walk off" or cause unsightly traffic lanes. Should a tile be damaged, it can be replaced quickly and relatively inconspicuously.

The very important combination of low initial cost, low maintenance cost and long trouble-free service not only helps to provide more school for the money initially, but also to save funds for the subsequent construction of more sorely needed additional educational space.

Design and Use Flexibility

Vinyl asbestos tile provides widest design and use flexibility. Virtually all types of school activity, no matter how diverse, can be conducted on vinyl asbestos tile. This makes it a particularly appropriate floor where flexible wall systems are planned in order to realize maximum utility of school facilities presently and in the future. An area used as a classroom one day may easily be converted to a library reading room or a music room or a science room the next day without concern about the floors. Physical movement of walls can be expedited over smooth and durable vinyl asbestos tile. Should the wall changes be made periodically to two or three predetermined alternate positions, these positions can easily be located each time by simply making them a part of a functional tile floor design.

While it can be used throughout the school, especially logical areas for the installation of vinyl asbestos tile are school entrances where there is a great amount of tracked-in dirt, corridors, cafeterias where food, liquids and vegetable oils are frequently spilled, school kitchens, offices, laboratories where chemicals may be used, locker rooms, and auditoriums. And it is perhaps the only flooring that can serve satisfactorily in a multipurpose gymnasium-cafeteria-auditorium area. With the use of feature strip, a regulation basketball court can be inset in the floor for basketball games. This floor will also withstand the abuse of physical education classes, or student social functions such as dancing, or as the auditorium seating area for school plays or graduation exercises. Because it is greaseproof it can also be used safely as a cafeteria lunch room. The only areas for which vinyl asbestos is not recommended are shower rooms, swimming pool areas, or areas exposed to outdoor weather. This versatility, of course, is not typical of most floor coverings.

Vinyl asbestos tile can be installed safely over concrete subfloors, on, above, or below grade, or over wood or plywood subfloors in virtually any room of the school building. However, it must be remembered that vinyl asbestos tile, as with all resilient floor coverings, will conform to the subfloor over which it is installed. As a result, any irregularities that exist in the subfloor will be "telescoped" through the tile.

Economy in Product and Installation

While offering the advantages of color, style, use versatility, ease of maintenance and durability, vinyl asbestos is the lowest cost vinyl tile and one of lowest cost of all types of flooring on the market. At the same time, because of the nature of the product and the adhesive used, installation cost on vinyl asbestos tile is generally the lowest of any resilient flooring material. No special, costly adhesives are necessary and the convenient size of the tile makes for faster, less expensive installation. Installed cost for a 20,000-foot school in vinyl asbestos tile will run approximately 25 to 35 cents per square foot, depending on the gauge of tile, size of rooms, local wage scale, etc. Exact cost can be determined by consulting local flooring dealers. Azrock vinyl asbestos tile is available through reputable flooring subcontractors throughout the United States. ◀◀

7

SIX REASONS WHY FLOORS OF AZROCK VINYL ASBESTOS TILE "MAKE SENSE" IN SCHOOLS

AN INFINITE variety of floor coverings, each designed for some selected use, is available on the market. However, the one flooring which combines those characteristics universally desirable in school floors is vinyl asbestos tile.

COLOR AND DESIGN FLEXIBILITY – Vinyl asbestos is available today in a broad spectrum of colors and styles which harmonize with the latest colors in school interiors. It is readily adaptable to decorative or functional designs.

EXCELLENT LIGHT REFLECTANCE – Among the colors available are many whose reflected light, as measured by a Photovolt Reflectance Meter, contribute materially to proper lighting and reading conditions in classrooms, study halls, or libraries.

ECONOMICAL MAINTENANCE – Because of the tightly textured composition of vinyl asbestos, dirt can't penetrate the surface. It stays on top where it can be easily swept away. When mopped or buffed regularly, vinyl asbestos requires only periodic scrubbing or waxing.

RUGGED DURABILITY – Vinyl asbestos colors with thru-styling can be installed in areas subject to severe abrasive traffic such as school entrances, stairway landings, or under desks. The pattern won't "walk off."

SAFETY-HEALTH FACTORS – Vinyl asbestos is fire resistant. It will not support combustion. And its smooth, non-porous surface makes it a sanitary floor less likely to trap germs or pollen which cause discomfort to students and teachers with allergies.

LOW INITIAL COST – Azrock vinyl asbestos tile is lower in initial cost than rubber, cork, "solid" vinyl, terrazzo, or wood, and significantly lower than carpet. Only asphalt tile is lower, and maintenance savings quickly recover this small difference.

WRITE FOR SAMPLES, color catalog, and maintenance cost studies: Azrock Floor Products, P. O. Box 531, San Antonio, Texas 78206.

fine floors by **AZROCK®**

Specialists in the manufacture of vinyl asbestos flooring tile

school: a home away from home

AMERICAN-STANDARD

The increasing activity in constructing new primary and secondary level schools may be the chief reason for the introduction of many built-in improvements in educational architecture. Indeed, many of these new conveniences are innovations designed to meet the primary function of a school: *the education of human beings under the most ideal conditions possible.*

Naturally, the best environment for a child is the home, the environment of which is so important in shaping the future of a human being. Happy and cheerful surroundings are the best tonic for growth of mind and body. And since a child spends so much of his time in a place of learning during his young life, it follows that the ideal environment for the process of formal learning be under conditions as near as possible to those found within his own home. Children learn to develop their sense of touch, taste, sight, smell and hearing under these conditions. They learn to crawl, walk and speak—really great marvels when you measure the cumulative accomplishment in ones so young. In short, they do extraordinarily well under conditions found in the home. It certainly follows that they deserve, and will prosper under, similar conditions for formal learning. Many schools in this country have realized this. They have succeeded in making their educational architecture "Homes away from Homes."

New Architectural Approach

These past ten years have seen enormous changes in school planning. The new approach to much school architecture takes into account the idea that the building must be a statement of a home; that is, with thorough planning of architectural styles, happy environment (landscaping and interior color styling), flexibility (of facilities and furniture) and maintenance.

The most interesting development in these truly modern schools occurs chiefly in the planning of the primary grade learning area. In this area, especially, have the planners tried to create atmospheres in which children feel "at home." In these buildings, individual toilets serve the first grade classrooms (and in some schools through the third grade) and are located directly off, or just beside the classroom. These toilets serve both male and female pupils. (Many imaginative school planners feel that individual classroom toilets should be used up through the sixth grade.)

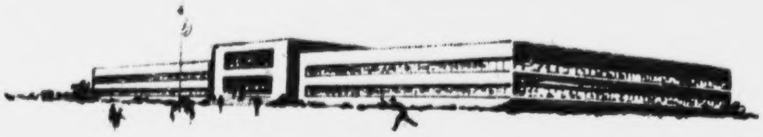
The advantages of individual classroom toilets are not at first realized, perhaps the reason for their long obscurity, but the advantages are many. Pupils can be better supervised by their teachers; that is, traffic can be kept at a minimum and handwashing after toilet use can be assured with this arrangement. There is less damage to walls with fixtures because individual pupil use of facilities greatly reduces the possibility of vandalism. Toilets directly off or adjacent to classrooms result in children's being able to use them at any time (like "at home")—not at specific times which always cause jam-ups, less sanitary conditions, and vandalism.

Other Advantages

Economy of installation is another and quite important advantage of individual classroom toilets. A noted consultant on school plant planning states that in an 18-classroom building, large "group" toilet rooms require approximately 2,000 square feet of interior floor space. In an 18-classroom building, individual classroom toilets require approximately *400 square feet!* There is also every indication (from alternate bids in similar situations) that the plumbing and fixtures cost considerably less than where they are installed in large toilet rooms.

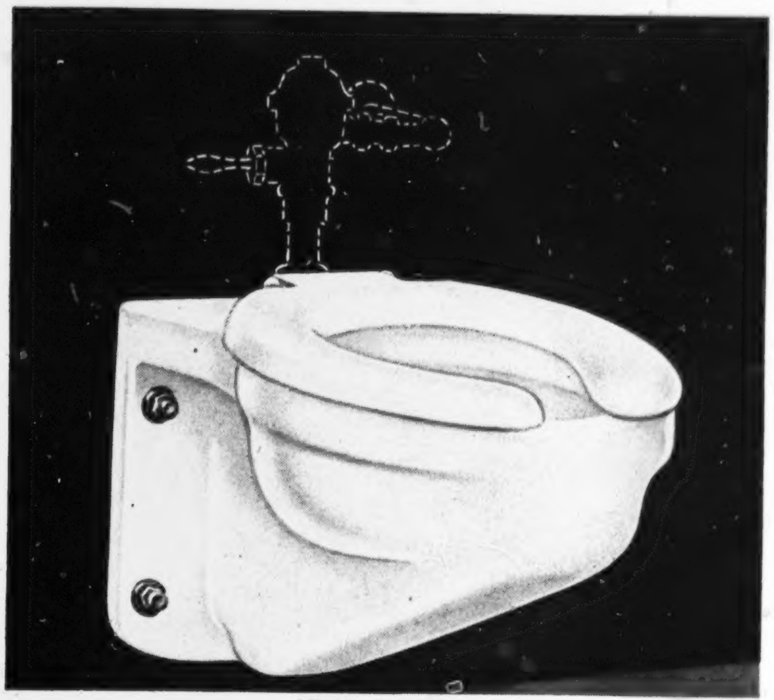
Plumbing fixtures used in these classroom toilet rooms should be carefully considered in regard to convenience and maintenance. A toilet should be considered which, when flushed, would not interfere with activities in adjacent classrooms. The AFWALL* Toilet is extremely quiet-flushing for non-disturbing operation and wall-hung to assure easy and fast maintenance. Its elongated bowl is a boon to keeping floors cleaner and more sanitary, especially with small boys. The Church seat is heavy duty, solid plastic or MOLTEX,* impact-resistant and sanitary, available with self-sustaining or self-rising hinges, a great asset where boys and girls use the same toilet.

Lavatories equipped with modern metering faucets that are vandal-proof will guard against water waste and damage. The new LUCERNE* Lavatory on a carrier offers an off-center bowl and a side ledge to hold books or pads.

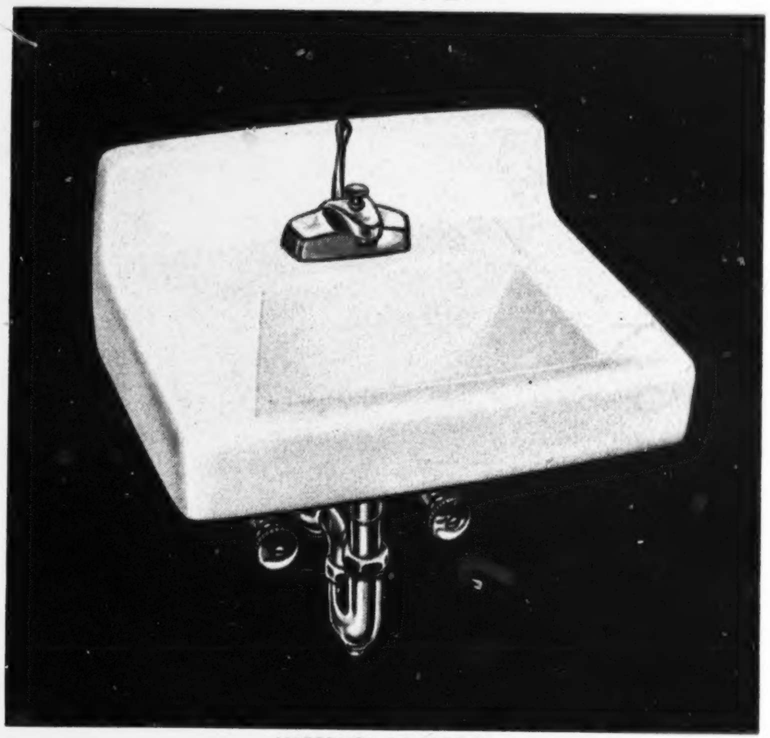


The **BUENA*** is another ideal lavatory for toilet room installation. Both are genuine vitreous china, easy to clean and keep clean. For extra convenience and shelf space, drop-in lavatories (like the new **RONDALYN***) can be installed in countertops. Countertops are especially convenient in faculty toilet rooms. **COREX**,* a non-staining, non-porous solid plastic, available in decorative colors and simulated woods and marbles, is ideal in maintenance, beauty and durability. (This material is also ideal for partitions, where they are required.) The use of urinals in these individual classroom toilets is by individual preference. They do help in general maintenance by decreasing the use of the toilet. The wall-hung

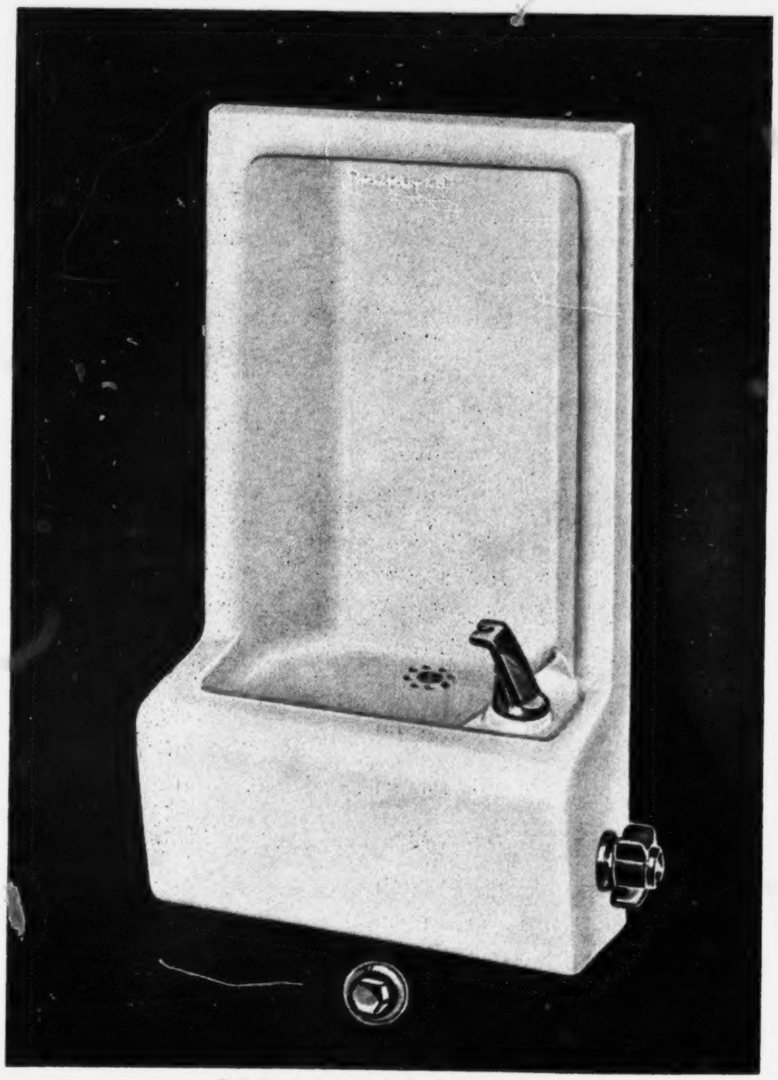
*Trademarks of American-Standard



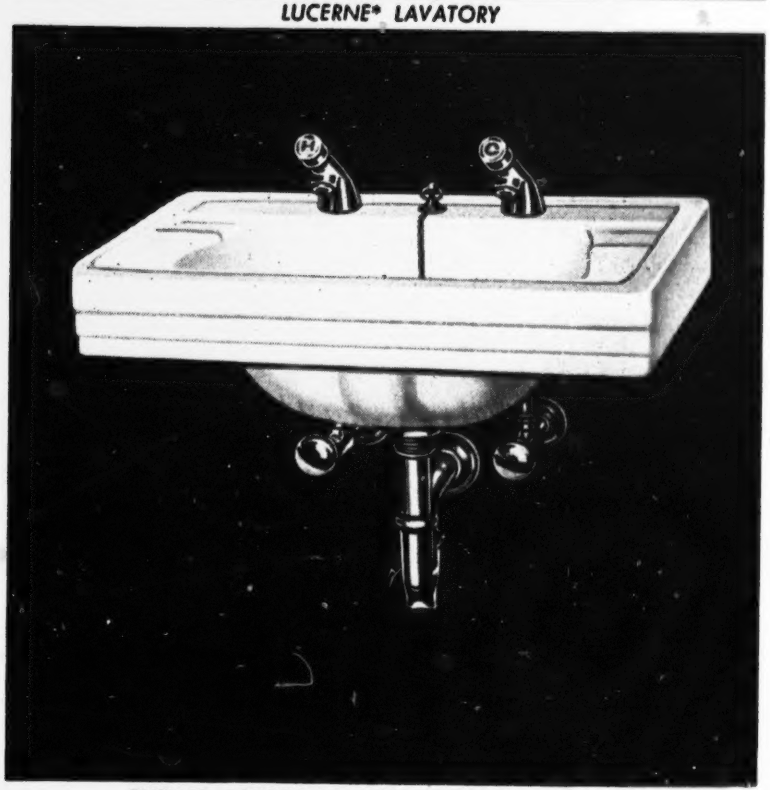
AFWALL TOILET*



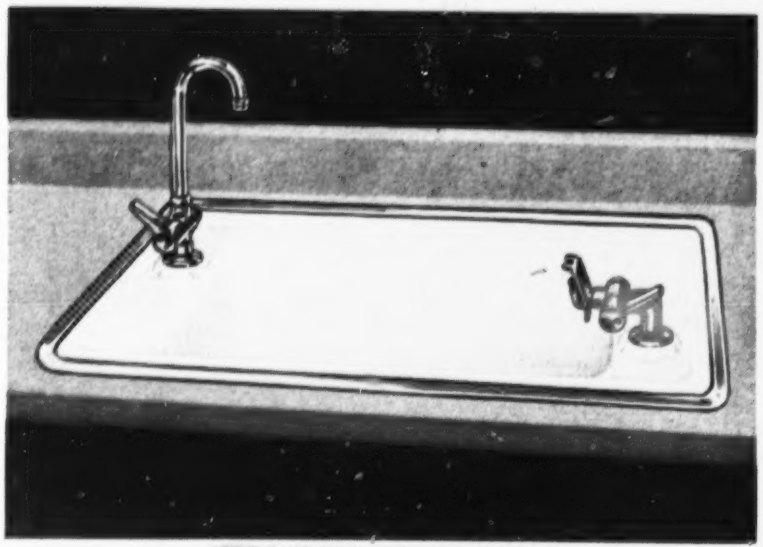
LUCERNE LAVATORY*



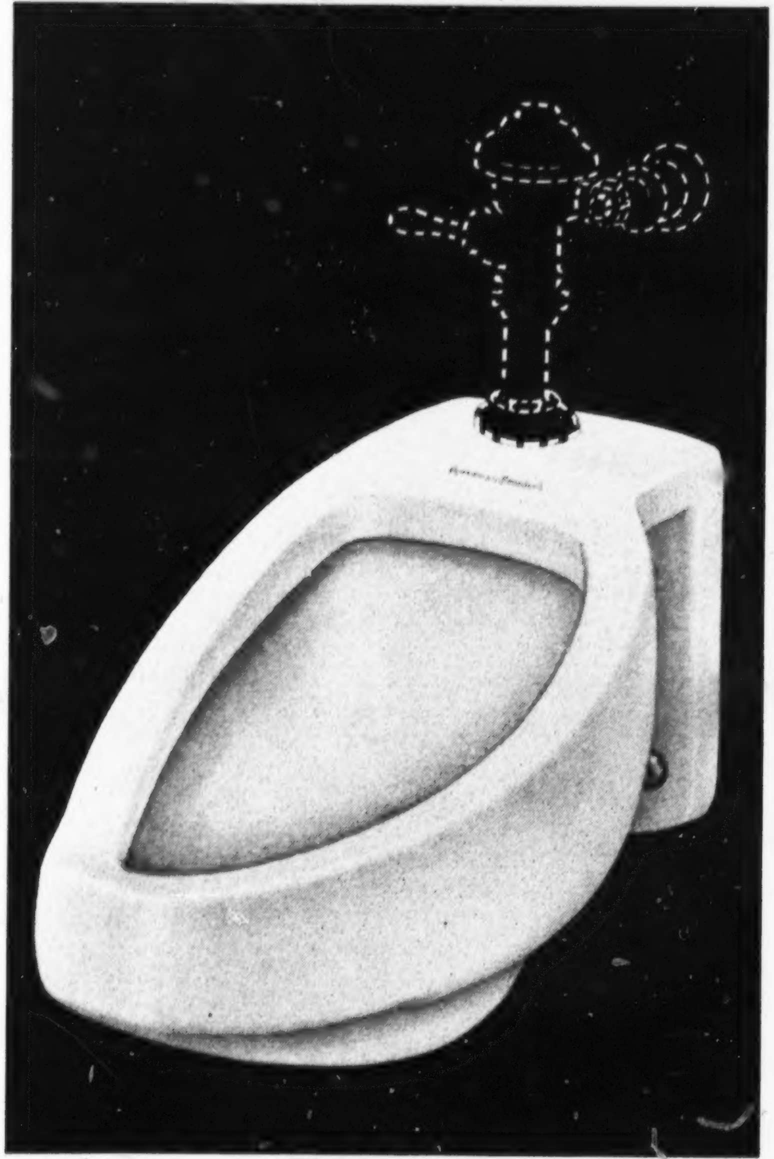
TIOGA DRINKING FOUNTAIN*



BUENA LAVATORY WITH METERING FAUCETS*



LEDGEWORTH* FOUNTAIN/SINK



JETBROOK* URINAL

COREX* DESK TOPS AND SEATS

Jetbrook* is an excellent choice because of the ease of fixture and floor cleaning.

Color here, as in the classroom, can play an important part in making this room like a bathroom in any of the students' homes. Pastels for walls and ceilings are recommended, along with fixtures in harmonizing colors or white.

Well-planned color schemes for classrooms are extremely important. Naturally, as much exposure as possible to the outdoors makes for the most healthy and ideal conditions, as well as offering the advantage of light, ventilation and the esthetics of the landscaping. Cheerful colors can make the gloomiest day as gay, and productive, as Springtime. Walls, ceilings, doors, floors and borders all can work hard to create an atmosphere as warm and friendly as the home. Furniture here is just as important to children as it is in their own homes. It must be comfortable, colorfully attractive and easy to clean and keep clean. It should also be mobile, so that flexibility of classroom arrangements is possible. It must also be durable. Educational furniture of Corex meets all these conditions admirably, whether it be used as chair seats and backs, desk tops or tablet arm tops. It is also perfect for the recent trend in many schools of eliminating school cafeterias because of the enormous waste of space for a one-hour lunch period only. Many schools now have a central kitchen (some progressive cities have one community kitchen which services the food requirements of all the schools in the city), and serving is done from heated and refrigerated carts, in each classroom. With this system, youngsters enjoy their lunches with their own school family, in one small room, "just like at home."

Elementary Area

The elementary learning area of well-planned schools also requires plumbing fixtures. Naturally, these additions should be placed, if at all possible, as near the classroom toilet for convenience as well as economy. A drinking fountain is a necessity, as is a sink for washing hands.

The Ledgeworth* is an ideal drinking fountain-sink combination and can be installed easily and attractively in Corex countertops. Where local codes do not permit drinking fountain-countertop sink combinations of this nature for schools, a Tioga* wall-recessed drinking fountain and Custom-Line* countertop sink are also perfect.

The plumbing fixtures necessary for a school have not all been mentioned here. Only some of the fixtures that lend themselves best to creating a home atmosphere in elementary classrooms have been discussed. Many plumbing fixtures are designed specifically to fill the needs of specific uses in schools. And with care and thought of their best use, with furniture and appliances designed specifically for schools, planners can create school buildings with ideal conditions for the physical and mental well-being of their inhabitants—"Homes away from Homes." ◄◄

*Trademarks of American-Standard

laminated plastic applications in schools

FORMICA CORPORATION

The most important features of decorative laminated plastic are design variety potential and an inherent resistance to wear or damage. Formica Corporation, acknowledged leader in the development of decorative laminates, has extended these basic product qualities into a wide variety of useful and economical applications. Many of these applications have obvious and immediate benefits in school construction and decorating.

Specifically, FORMICA is a brand of high pressure laminated plastic. The product is decorative as well as functional, characterized by extreme hardness and excellent resistance to cracking, crazing and other blemishes. The surface is unharmed by ordinary solvents such as alcohol, boiling water, household acids and alkalies. The material will withstand direct heat to 275°. The color, pattern and woodgrain effects, combined with a selection of finishes, are many and varied. There are design possibilities for coordinating entire buildings, or treating separate areas with flair and individuality.

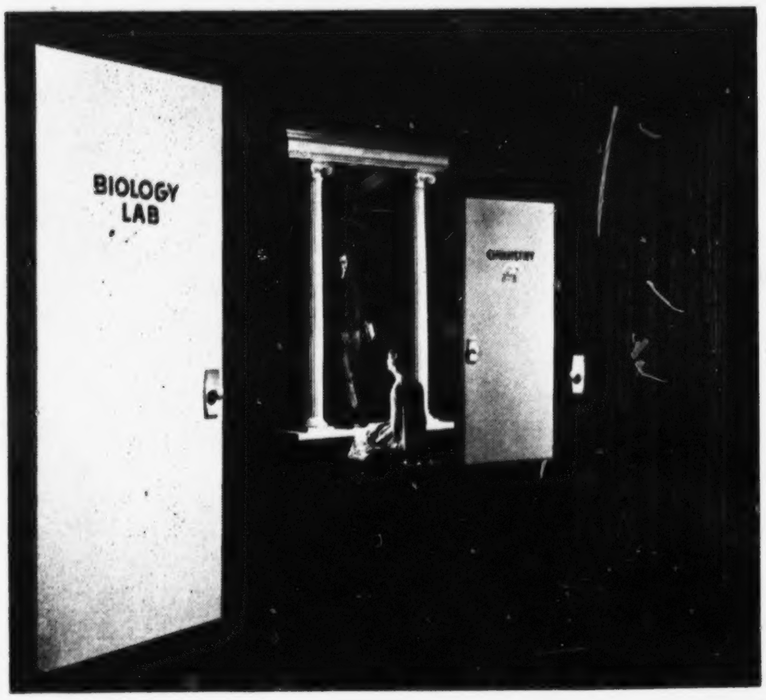
FORMICA brand laminated plastic qualifies as a most economical building product. Recurring "after costs" of maintenance and refinishing are eliminated. The durability and ease of maintaining FORMICA laminate surfaces is one of this contemporary product's most appealing features in school construction. It is vandal-resistant since the melamine surface cannot be readily penetrated by common writing instruments. Surface soil can be removed repeatedly without visible effects, and the surface resists any deterioration from harsh cleaning agents, except those with abrasive content.

Applications of laminated plastic in school construction are unlimited where the needs of durability and design are best served. Of immediate interest to school designers are such applications as doors, wall paneling, counter and laboratory tops, built-in storage cabinets, desk and work table surfacing, convector covers and window stools, toilet compartments and any number of case piece applications—all of which, when surfaced with laminated plastic, will create a more pleasant interior coupled with maintenance economy and long wear.

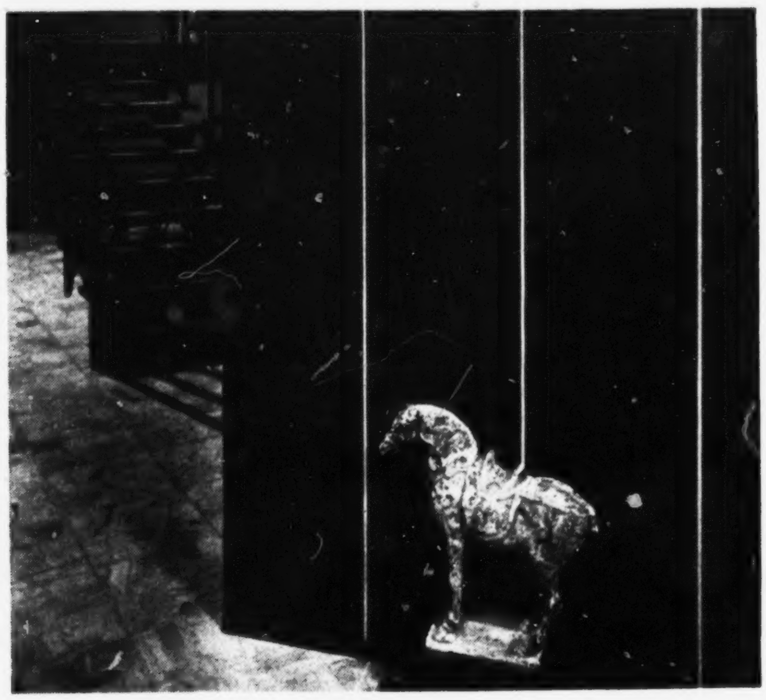
Doors

Interior solid core doors clad with FORMICA laminated plastic are precision made to Formica Corporation approved specifications by Authorized Door Manufacturers located throughout the United States. Doors receive the most frequent and most damaging wear of any building

FORMICA brand laminates: *. . . for doors*



. . . for wall paneling



component. Trouble-free and work-free, these doors are guaranteed for the life of the installation, and preclude the high costs of refinishing and repair. Such doors are also delivered to the job site, packaged in individual containers and pre-mortised to receive specified hardware. Fitting and installation time are reduced to an absolute minimum.

In addition to the standard line of colors, patterns and woodgrains, custom screen prints can be ordered for permanent designs or legends. Special purpose doors are also available, including acoustical, X-ray, fire-rated 1 and 1½ hour, and with vent louvers and lights.

Wall Paneling

The applications for a durable wall surfacing in schools are endless. Corridors, classrooms, play areas, laboratories, locker rooms and offices are but a few. The Formica brand wall paneling system (V.I.P.*) is readily adaptable to new or remodeled structures. Wainscot and floor-to-ceiling applications are equally easy, subject only to the specific needs of the area.

A unique spline and molding package permits fast installation. The exposed laminate surface is extremely durable, and is available in a variety of woodgrain or pattern designs. Grains and patterns may be selected to match or contrast with other laminate applications in the area.

Fire hazard classifications of these panels are as follows:

Class II V.I.P.	*Fire Hazard Classification*		
Fire Rated Panel	*Core*	*Face*	*Back*
Flame spread	20	45-60	35
Fuel contributed	10	25	15
Smoke developed	5-45	55-105	0

Counter and Laboratory Tops

Perhaps the most familiar of all laminated plastic applications is on counter and laboratory tops. Such areas would include reception desks, work and storage counters and tops for science labs. Such areas must be resistant to normal wear of books, teaching aids, projection equipment and accessories. Material for laboratory tops has the added advantage of being impervious to extremes of temperature as well as staining and deterioration of standard reagents.

The following reagents show essentially no effect on Formica laminate when left in contact for periods up to 16 hours:

Acetic acid	98%	Sulphuric acid	77%
Citric acid	10%	Perchloric acid	60%
Hydrachloric acid	37%	Phosporic acid	85%
Formic acid	90%	Phenol	85%
Nitric acid	30%		

Built-ins

The most frequently encountered are convector covers, storage cabinets for libraries and classrooms, window stools and case goods, built-in or portable. For applica-

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*Trademark

FINISHES

Pattern Category	*Standard Finish*	*Optional Finishes*
Woodgrains	Furniture	Suede
Black	Furniture	None
White	M	Suede
Solid Colors	M	Suede
Special Designs	To Order	Furniture Satin, Suede . . . M only when needed to match solid colors
V-32	Suede	None
Patterns		
Linens, Capri	Furniture	Polished
Mayflower, Frosts	"	"
Tidestone, Pinwheel	"	"
Finesse, Sequin	"	"
Spindrift	"	"
Willow, Fernglo	"	"
Cremo Marble	Polished	Furniture
Lioz Marble	"	"

Descriptions	*Gardner Gloss Meter 60° Specular Gloss Reading*
Furniture—A semi-gloss finish achieved by special machining of the surface.	40-60
Suede—Minutely grained texture with low reflective surface, for both horizontal and vertical surfaces.	10-15
Polished—A high gloss finish specially suited to applications where maximum smoothness and luster are desired.	80-100
M Finish—A semi-gloss finish especially developed for solid color stain resistance. Exclusive with Formica Corporation.	20-40

PERFORMANCE CHART

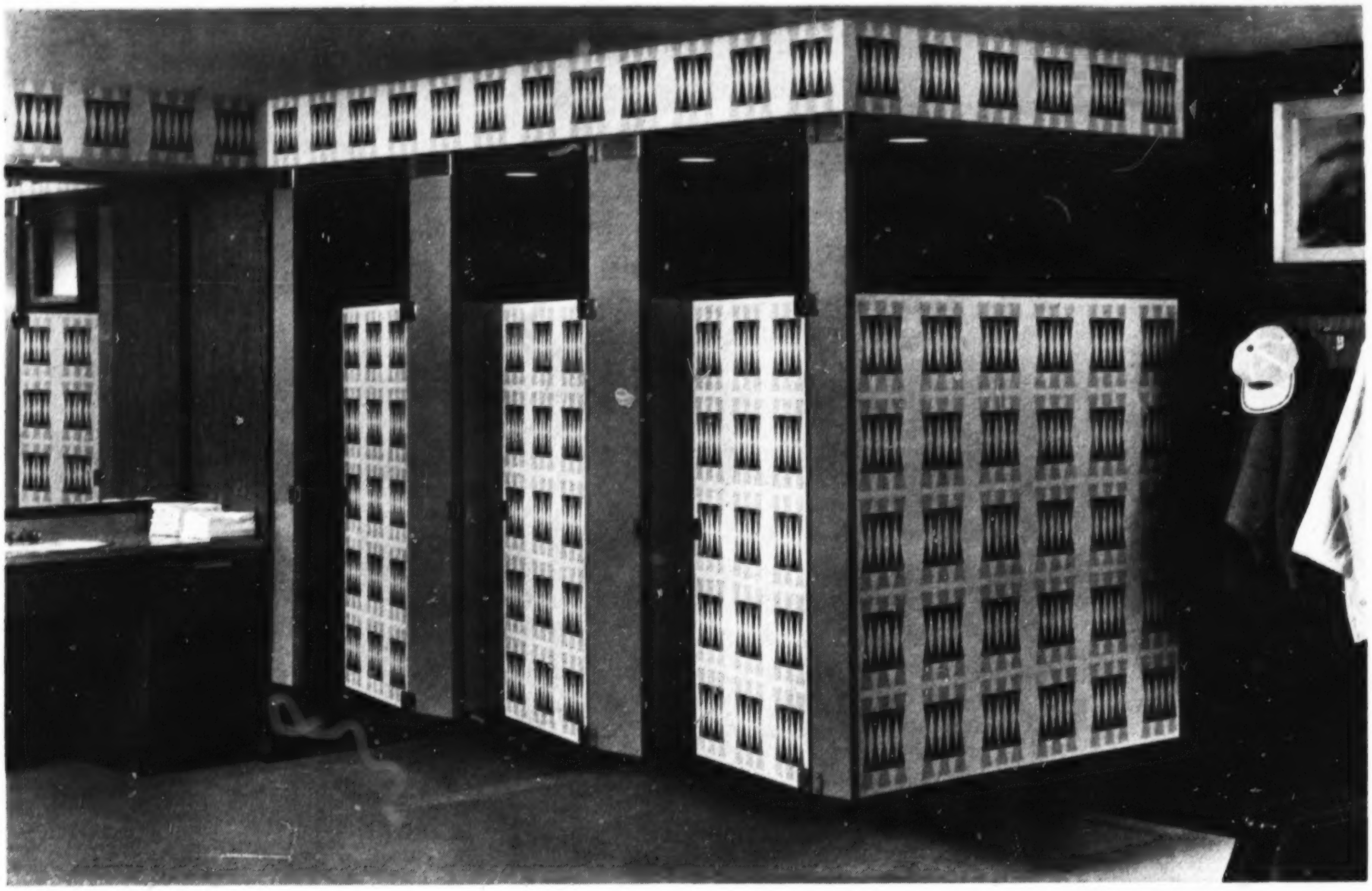
Formica Laminated Plastic Average Values

The test performance of Formica is far in excess of industry standards. In any "or equal" specification, Formica Corporation suggests you use this performance chart to establish quality standard.

*TEST**	*1/16 STANDARD GRADE Formica Values*	
Weight (lbs) ft^2	.45 lbs/ft^2	
Abrasion	516 cycles**	
Rate of Wear/100 cycles	.06 gms.	
Surface Resistance to Boiling Water	no blisters	
Surface Resistance to High Temperature	satin—no blisters & no surface disturbance gloss & furniture finish—no blisters, slight dulling	
Cigarette Test	138 seconds	
Color Fastness	no crazing—slight color change	
Water Absorption	6.10%	
Thickness Swell	6.09%	
Dimensional Change	0.2% in length 0.6% in width	
	Lengthwise	*Crosswise*
Flexural Strength (in psi)	face up: 32,750 face down: 20,800	22,000 15,000
	Lengthwise	*Crosswise*
Modulus of Elasticity (in psi)	face up: 2,200,000 face down: 1,900,000	1,900,000 1,700,000
Deflection at Rupture	face up — .04 face down— .02	

*Tested in accordance with NEMA LP2-1957, using samples selected at random from production run.

**Patterns and woodgrains only. Solid colors not included. Average abrasion for solid colors approx. 800 cycles.



FORMICA brand laminates: *. . . for toilet compartments*

. . . for counter and laboratory top

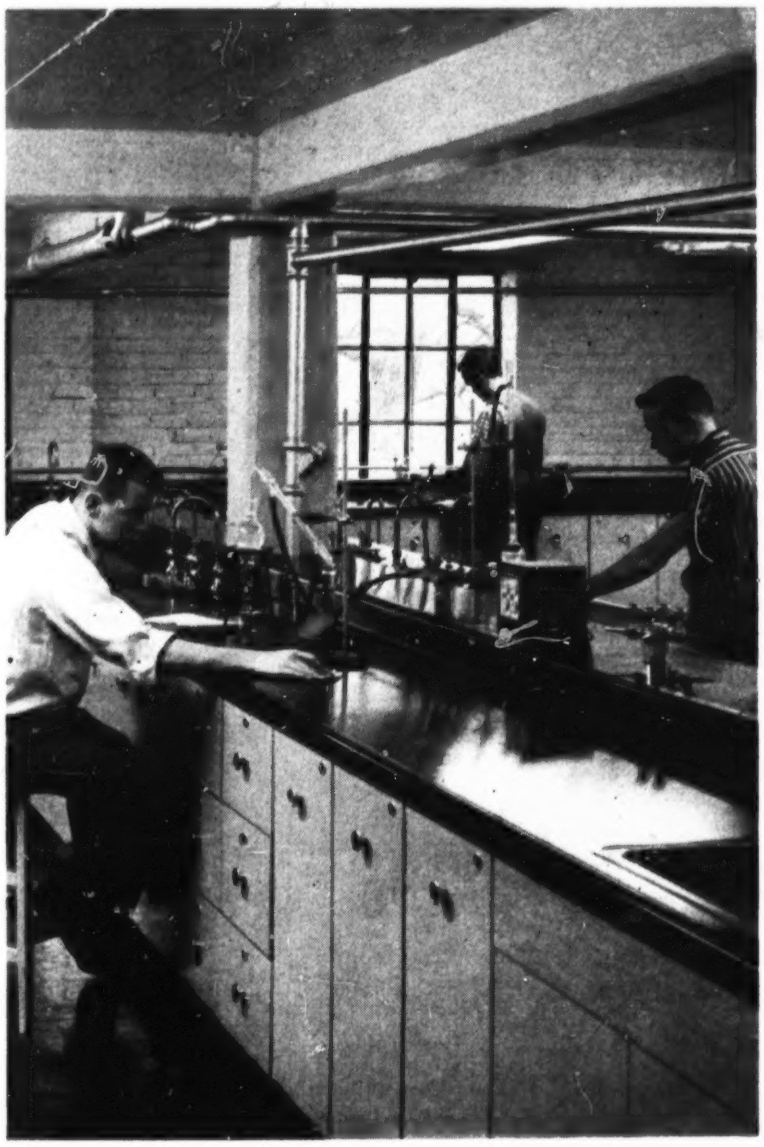
tions of a permanent nature, the need for a hard wearing exterior is primary. Coupled with the design capabilities of laminated plastic, such installations can provide long-range economy and long wearing beauty not possible with other materials.

Toilet Compartments

Toilet compartments are a relatively new application of laminated plastic. The need for such a development is evident when considering that other materials, regardless of cost, do not offer the design potential of decorative laminate. For example, FORMICA brand toilet compartments are readily available in 44 distinct solid colors, as well as an exclusive series of permanent decorative screen print designs. This permits the interior designer a much greater latitude in selecting color schemes for this often overlooked facility.

Laminate-surfaced toilet compartments are rust proof. As in other applications, the permanence of the material eliminates costly maintenance and refinishing. Both durability and design are built-in deterrents to vandalism. The melamine surface of FORMICA laminated plastic is also unaffected by urine, cleaning solvents or harsh detergents.

The appealing characteristics of FORMICA laminated plastic are many and varied, both in terms of physical properties and æsthetic appearance. Fully exploited and properly coordinated, the material can make a substantial contribution to the high service and low cost of school structures. ◀◀



SEMINAR SPONSORS AND THEIR SCHOOL PRODUCTS

American Gas Association • 605 Third Avenue, New York, New York 10016
Natural gas—energy for heating, cooling, cooking, and incineration

American Iron and Steel Institute • 633 Third Avenue, New York New York
Steel products used throughout the school building

American Radiator & Standard Sanitary Corporation • 40 West 40th Street, New York, N.Y. 10018
Plumbing, heating, air conditioning and school furniture

Azrock Floor Products • P. O. Box 531, San Antonio, Texas 78206
Azrock vinyl asbestos floor tile

Butler Manufacturing Company • 7400 East 13th Street, Kansas City, Missouri 64126
Space Grid—system of architectural component construction

Curtis-Electro Lighting, Incorporated • 1536 South Paulina Street, Chicago, Illinois 60608
Aluminum luminaires for classrooms

E. I. duPont de Nemours & Company, Inc. • Wilmington, Delaware 19898
TEDLAR PVF film—a preformed, pre-tested finish for building products*

Edison Electric Institute • 750 Third Avenue, New York, New York 10017
Electricity for heating, cooling, lighting, cooking, etc.

Formica Corporation • 4614 Spring Grove Avenue, Cincinnati, Ohio 45232
Walls, doors and toilet compartments clad with Formica laminated plastic

The E. F. Hauserman Company • 5711 Grant Avenue, Cleveland, Ohio 44105
Demountable partitions, operable walls, and acoustical ceilings

Johns-Manville Corporation • 22 East 40th Street, New York, New York 10016
Roofing, insulation, acoustics, curtain walls, chalkboards and floor tile

Kawneer Company • 1105 North Front Street, Niles, Michigan 49120
Aluminum windows, entrances, curtain walls, and railings

Koppers Company, Inc. • Koppers Building, Pittsburgh, Pennsylvania 15219
Structural laminated wood, timber decking, coal tar built-up roofing

Libbey-Owens-Ford Glass Company • 811 Madison Avenue, Toledo, Ohio 43624
Parallel-O-Plate-grey-bronze, heat absorbing plate, thermopane, sheet glass

National Forest Products Association • 1619 Massachusetts Avenue, N.W., Washington, D. C. 20036
Structural wood, paneling, millwork, flooring, furniture, etc.

Pittsburgh Plate Glass Company • One Gateway Center, Pittsburgh, Pennsylvania 15222
Environmental glass and chalkboard

Rohm & Haas Company • Independence West, Philadelphia, Pennsylvania
PLEXIGLAS acrylic plastic for glazing, skylights and lighting*

The Steelcraft Manufacturing Company • 9017 Blue Ash Road, Cincinnati, Ohio 45242
Metal doors, metal door frames and transom, sidelite and entrance units

Structural Clay Products Institute • 1520 18th Street, N.W., Washington, D. C. 20036
Brick, structural clay tile, and structural facing tile

Zonolite Division, W. R. Grace & Co. • 135 South LaSalle Street, Chicago, Illinois 60603
Thermal insulation, fireproofing, and acoustical treatments

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*Registered trademark

"In the life of the individual, education is always an unfinished task, and in the life of the Nation, the advancement of education is a continuing challenge. Nothing matters more to the future of our country: not our military preparedness—for armed might is worthless if we lack the brain power to build a world of peace; not our productive economy—for we cannot sustain growth without trained manpower; not our system of democratic government—for freedom is fragile if citizens are ignorant."

—LYNDON B. JOHNSON

SYMBOL DESIGN SYNOPSIS In one context a school building, irrespective of classification or type, may be regarded as the physical manifestation of the idea of education. The desire and quest for knowledge are intrinsic and compulsive facets of man's constitution. While the process of expanding the intellect has an initiation, it has no termination, and one may conclude that mankind will never reach the zenith of his mental development. Hence, infinity and the sign representing it seems most appropriate as the nucleus element upon which to base design. The manipulation and attenuation of the source form, geometric juxtapositioning and rotation, and the counter balancing of projection are intended to express the dynamic action, reaction and interaction not only synonymous with education itself, but with the process by which structures intended to provide an academic environment are in fact forged. The vibrant colors and the movement from darker to lighter accent the theme. Symbolism is a viable part of man's heritage. Its impact and importance have been clearly recognized through the ages though in contemporary society its value is frequently dismissed; its presence often ignored. However, when applied with restraint and wit, symbolism is an effective devise in evoking a positive emotional response by forcing the observer to participate actively in compositional comprehension. When most cogent, symbolism as the distilation of an idea is a means to an end, not a calculated end in itself. It has been within this discipline that the design was evolved.

THE DESIGNERS **William E. Leonard.** Mr. Leonard received his professional training at the Cincinnati Academy of Fine Arts and the Yale University Summer Seminars in Norfolk, Connecticut. Since 1957, he has operated his own graphic design studio and in June, 1964, became the director of the Cincinnati Contemporary Arts Center. Slightly over a year ago Mr. Leonard joined the faculty of the College of Design, Architecture and Art at the University of Cincinnati as an instructor in Graphic Design.

David L. Niland. In 1952, Mr. Niland received a Bachelor of Arts Degree from Denison University in Granville, Ohio, followed by a Bachelor and Masters Degrees in Architecture from Yale University in 1959 and 1960 respectively. During 1960-61, he studied in Denmark on a Fullbright Grant and traveled extensively throughout Europe on an American Institute of Architects Fellowship. Currently Mr. Niland is Chief of Design in the firm of Samuel Hannaford & Sons, Architects, and faculty architectural design critic at the University of Cincinnati.